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Part III

Department of Housing and Urban Development

Office of the Assistant Secretary for Housing—Federal Housing Commissioner

Revision of Minimum Property Standards for One- and Two-Family Dwellings

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

Office of Assistant Secretary for Housing—Federal Housing Commissioner

[24 CFR Part 200]

[Docket No. R-80-857]

Change to Minimum Property Standards (MPS) for One- and Two-Family Dwellings

AGENCY: Department of Housing and Urban Development (HUD).

ACTION: Proposed rule.

SUMMARY: This revision is made to incorporate appropriate portions of the current model One- and Two-Family Dwelling Code into the MPS for One- and Two-Family Dwellings and to remove criteria from the MPS that do not bear directly on health, life safety, legislative requirements, or durability, and to reduce the bulk of the standards and to update and relocate criteria as appropriate.

COMMENTS DUE: November 17, 1980.

ADDRESSES: Comments should be addressed to the Rules Docket Clerk, Office of General Counsel, Room 5218, Department of Housing and Urban Development, 451 7th Street, S.W., Washington, D.C. 20410. Comments should refer to the above docket number and title. Copies of any comments received will be available for examination during regular business hours at this address.

FOR FURTHER INFORMATION CONTACT: Donald R. Fairman, Office of Architecture and Engineering Standards, Department of Housing and Urban Development, 451 7th Street, S.W., Room 6170, Washington, D.C. 20410, telephone (202) 755-6590. (This is not a toll-free number.)

SUPPLEMENTARY INFORMATION: HUD Minimum Property Standards are published in Handbooks: MPS for One- and Two-Family Dwellings 4900.1, MPS for Multifamily Housing 4910.1, and MPS for Care-Type Housing 4920.1. The MPS are incorporated by reference into 24 CFR 200.927. All substantive changes in the MPS are required by 24 CFR 200.933 to be published in the **Federal Register** using the same procedure as for the publication of regulations. The proposed changes to the MPS 4900.1 are available for examination in all HUD Field Offices and in Headquarters Room 6170, Office of Architecture and Engineering Standards at the above address during regular business hours.

A draft Environmental Impact Statement (EIS) in conformance with the National Environmental Policy Act of 1969 has been prepared for this change in accordance with HUD procedures, and is available in the Office of the Rules Docket Clerk at the above address for inspection and copying. A draft Regulatory Analysis with respect to Economic Impact has also been prepared and is available in the Office of the Rules Docket Clerk for inspection and copying.

This rule is not listed in the Department's semiannual agenda of significant rules, published pursuant to Executive Order 12044.

The Minimum Property Standards are used as requirements for all new residential construction associated with Departmental programs. These include Public Housing, Insured Mortgage programs and new construction associated with Section 8 programs. Depending on structure type, such housing is covered by the MPS for One- and Two-Family Dwellings, Multifamily Housing or Care-Type Housing. Row houses and attached dwelling are covered under the MPS for One- and Two-Family Dwellings.

In a careful examination of the regulatory process a Departmental decision has been reached to revise the MPS for One- and Two-Family Dwellings, 4900.1. The major reasons for this revision are:

1. To conform with Task Force on Housing Costs recommendations for:

a. reconciliation of the MPS with HUD-approved provisions of the Model Code pending the development of an acceptable revision,

b. encouraging local jurisdictions to adopt a revised consensus version of the model One- and Two-Family Dwelling Code,

c. changes to the MPS to enhance design flexibility to encourage the construction of basic, low-priced starter houses, and

d. removal of unessential cost-increasing technical and design requirements from the MPS.

2. To make the criteria for HUD-associated housing more compatible to criteria for conventionally financed units.

3. To clarify, simplify, avoid duplication, reduce the sheer volume of the MPS, and to eliminate conflicts in interpretation in communities where the model code is used.

4. To place increased responsibility for marketability determinations in the local Field Office where personnel are more familiar with the needs and desires of the immediate market area.

5. To conform with the Administration policy to reduce regulation and paperwork.

Over the years, the MPS have been developed to contain provisions designed to assure inclusion of features which may be characterized as serving livability and marketability. A major element in this proposed revision to the MPS is the removal of those requirements. It is the Department's belief that livability and marketability needs for single family housing are being adequately fulfilled in conventionally financed housing and should no longer be the subject of mandatory Federal requirements in MPS 4900.1. Determinaton on marketability and livability of units associated with HUD programs will become the nonmandatory responsibility of field office staff who are more familiar with local needs and customs.

In other words, under the proposed revised MPS, HUD would not require that these elements be included in housing construction for a building to be eligible for participation in HUD programs. This does not mean that these items will not appear in HUD housing. Rather, their inclusion or exclusion will be determined by buyer wants and needs and considered in the HUD appraisal process rather than being mandated in standards.

The changes included in this revision may be characterized as being of nine types. Their general content, and illustrative elements to be deleted are as follows:

1. Removal of livability and marketability criteria found primarily in Chapters 3 and 4. These include, but are not limited to: Requirement for orderly and efficient site design quality; consideraton of resident social and physical needs in site design such as age and income levels, family composition, and local customs; preservation of good vegetation; site design for optimum climatic confort; provision of usable outdoor space; building setbacks to mitigate exposure and traffic disturbance; coordination of necessary access to adjoining properties with local plans; separation of public walks from windows for privacy; design for economic construction and maintenance for utilities; use and application of new plant materials; provision of laundry drying yards where needed; provision of space for active and passive recreation; provision of appropriate recreation equipment; provision of convenient commercial space when needed avoiding land use conflicts; room sizes and furnishability requirements for living and dining rooms and bedrooms; kitchen food preparation and storage

space; provision of bathroom accessories and water impervious wainscot around showers; provision of bedroom, coat, linen and general storge closets; minimum widths for private doors; privacy locks for bathrooms and primary bedrooms; provision of attic or crawl space access for passage of installed equipment and bedroom to bathroom access without passage through another habitable room;

2. Replacement of MPS criteria with similar or equivalent requirements from the current model One- and Two-Family Dwelling Code where appropriate in Chapters 4, 5, and 6. These include, but are not limited to: Simplified and less detailed room size criteria; reduced kitchen criteria for baths; new garage planning requirements; comparable ceiling height, exit and light and ventilation for private spaces criteria; less detailed stairway requirements; equivalent flame spread criteria; more detailed fire safety criteria for foam plastics; similar lumber requirements; equivalent footing criteria and equivalent criteria for basement walls;

3. Introduction of a basic measurement of workmanship similar to the homeowners warranty program, where possible, in chapters 3 and 6 providing increased assurance of an acceptable quality of workmanship;

4. Introduction of new energy conservation criteria in Chapters 5 and 6;

5. Updating seismic criteria in Chapter 6;

6. Elimination of quotations from referenced standards in Chapters 5 and 6 where material is available from other sources;

7. Removal of requirements for existing housing relocated in HUD Handbook 4905.1;

8. Elimination of program oriented criteria and quantification for handicapped construction from Chapters 3 and 4 for relocation in program literature and;

9. Elimination of requirements for the seasonal homes program from chapters 1 through 6.

Authority: (Sec. 7(d) of the Department of HUD Act (42 U.S.C. 3535 (d)).)

Issued at Washington, D.C., August 8, 1980.

Lawrence B. Simons,

Assistant Secretary for Housing—Federal Housing Commissioner.

Introductory Statement

These Minimum Property Standards are intended to provide a sound technical basis for the construction of housing under the numerous programs of the Department of Housing and Urban Development. The standards describe those characteristics in a property which will provide present and continuing utility, durability, economy of maintenance, and a safe and healthful environment.

A property complying with these standards is considered technically adequate in all HUD field office jurisdictions. The requirements contained herein define the minimum level of quality acceptable to HUD in each specific condition. The use of minimum standards alone, however, will not necessarily achieve an acceptable or desirable end-product. Other factors and considerations affect the acceptability of the property as a whole. Procedures for evaluation of design considerations are set forth in Handbook 4145.1, Architectural processing and Inspections for Home Mortgage Insurance. Other considerations related to physical improvements are set forth in Handbook 4135.1, Procedures for Approval of Single Family Proposed Construction Applications in New Subdivisions, Handbook 4150.1, Valuation Analysis for Home Mortgage Insurance and 24 CFR Part 50, Procedures for Protection and Enhancement of Environmental Quality.

Consideration of environmental quality is also necessary. As a general policy, development of all properties must be consistent with the national program for conservation of energy and other natural resources, and care must be exercised to avoid air, water, land and noise pollution and other hazards to the environment. Orderly and efficient development responsive to resident needs, preservation of good existing natural surroundings, conservation of fossil fuels and careful consideration of environmental factors are basic to the exercise of this policy. In this regard compliance with Federal floodplain and Wetlands policies (Expressed in Departmental Regulations and Instructions, Executive Orders 11988 and 11990, etc.) shall be observed. The advantageous utilization of climate, the design of usable space, arrangement of convenient circulation and adequate accommodation of services are broad functional goals in residential design which depend heavily on environmental considerations of a detailed nature. Designs which are evolved in the overlapping considerations of layout, energy conservation, grading, drainage, utility location and the use and preservation of plant materials are highly important to the degree of success exhibited by the functional aspects of the overall environmental design.

The Minimum Property Standards consist of four volumes of mandatory standards. These are One- and Two-Family Dwellings, 4900.1; Multifamily Housing, 4910.1; and Care-Type Housing, 4920.1; and Solar Heating and Domestic Hot Water Systems, 4930.2.

Supplementary standards for elderly housing are listed in 4900.1 and 4910.1. A Manual of Acceptable Practices, 4930.1, contains back up and illustrative material for the three volumes of mandatory standards.

An effort has been made to present the material in the standards in the simplest manner that will define a minimum level of acceptability and allow consistent interpretation by all users. Codes and standards do not ordinarily encompass degrees of workmanship but assume a journeyman level of production will be provided. Criteria are included which are similar to that in homeowner warranty programs. Performance definitions of materials and levels of workmanship have been included with consideration for the characteristics of the materials and normally acceptable workmanship. These additions add assurance that an acceptable level of workmanship will be provided for the homeowners. These requirements place a responsibility on the construction industry for the provision of a level of quality in housing that has not existed previously in the MPS. The standards are oriented to types of buildings rather than to programs or type of occupancy. Where practicable, requirements are stated in performance terms to permit flexibility. Dependence has been placed upon nationally recognized building industry standards and reference to them is employed in the several appendices to each volume.

Where no specific level of performance is stated in the standards, the Manual of Acceptable Practices may be used to determine acceptance or equivalence. This manual is not an additional standard, but is intended, as the name implies, to provide illustrations and data representing good current practice in residential construction technology. It provides a broad coverage of information and is a guidance document only.

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CHAPTER 1

General Use

100 *Application.*
100–1 Proposed Construction.
100–1.1 *General.*

These Minimum Property Standards for proposed housing apply to buildings and to the sites upon which they are located. The

buildings may consist of detached, semi-detached, duplex, or row houses. They may be site-built or factory manufactured. These standards also cover the immediate site environment for the dwellings, including streets, storm water disposal, and other services and facilities for the site.

100–1.2 *Housing for Elderly.*

Variations, additions and exceptions to the basic standards for the above types of housing which are applicable to housing for elderly are identified in these standards by italic type.

100–1.3 *Housing for Physically Handicapped People.*

Changes for housing and facilities for physically handicapped people are printed in capital letters.

100–1.4 *Multifamily and Care-Type Housing.*

Standards for buildings other than those described above are contained in the Minimum Property Standards for Multifamily Housing, 4910.1, and in the Minimum Property Standards for Care-Type Housing, 4920.1.

100–2 Existing Construction.

Existing construction shall comply with the Requirements for Existing Housing—One to Four Family Living Units, Handbook 4905.1.

100–3 Rehabilitation Construction.

One- and two-family dwellings involving rehabilitation shall be guided by Handbook 4940.4, Minimum Design Standards for Rehabilitation for Residential Properties.

101 *Variations to Standards.*

101–1 New Materials and Technologies.

These standards are intended to encourage the use of new or innovative technologies, methods or materials. See 613. Alternatives, nonconventional or innovative methods and materials shall demonstrate, however, equivalent quality to these standards in structural soundness, durability, economy of maintenance or operation and usability.

101–2 Special Conditions.

Certain conditions in the geographic area or on the site may justify modification of specific standards, or make compliance with the standards impacticable or impossible. In these cases, variations in accordance with procedures given in 101–4 may be permitted.

101–3 Higher Standards.

The Minimum Property Standards are essentially min.; consequently, the field office may, for specific cases, require compliance with higher standards than contained herein where considered necessary to obtain those characteristics of livability, utility, services and low maintenance expense to assure continued acceptance. See Variation Procedures 101–4.

101–4 Variation Procedures.

101–4.1 Variations to design and planning standards and to construction methods and materials demonstrating equivalency shall be made in the following ways:

a. For a particular design or construction proposed to be used on a non-repetitive basis for a specific case or project, the decision is the responsibility of the field office. Headquarters concurrence is not required.

Exception: Any Request for a Variation to the Criteira for Accessibility to Physically Handicapped People, Substantiating Data and Background Information Shall Be Submitted by the Field Office to the Director, Office of Independent Living for the Disabled, HUD, Washington, D.C. for Determination of Acceptance.

b. Where a variation is intended to be on a repetitive basis, a recommendation for a Local Acceptable Standard, substantiating data, and background information shall be submitted by the field office to the Director, Office of Architecture and Engineering Standards, HUD, Washington, D.C. for determination of acceptance.

101–4.2 Variances which require individual analysis and decision in each instance are not considered as repetitive variances even though one particular standard is repeatedly the subject of variation. Such variances are the subject of Section 101–4.1a above. The decisions in these instances are properly made by trained field office staff, architects, engineers and land planners, who have first-hand access to the information necessary to make them.

102 *Local Codes and Regulations.*

102–1 Standards as Codes.

102–1.1 These Standards are not intended to serve as a building code. Such codes are primarily concerned with factors of health and safety and not the many other aspects of design and use which are included herein as essential for continued acceptance by the occupants.

102–1.2 Where the local code, regulation or requirement permits lower standards than required herein, these Minimum Property Standards shall apply. In the event the local code, regulation or requirement precludes compliance with these standards, the property may be ineligible unless the intent set forth herein is fully attained by the alternate means proposed.

102–2 Compliance With Codes.

102–2.1 These standards shall not be construed as relieving the builder of the responsibility for compliance with local ordinances, codes and regulations including established requirements of a health authority having jurisdiction.

102–2.2 The Department of Housing and Urban Development does not assume responsibility for enforcing or determining compliance with local codes and regulations or make interpretations regarding their application in any specific instance.

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CHAPTER 2

General Acceptability Criteria

200 *General.*

These general acceptability criteria, together with other adminstrative rules and regulations are the basic criteria for eligibility.

201 *Real Estate Entity.*

The property shall comprise a single plot except that a primary plot with a secondary plot for an appurtenant garage or for other use essential to the marketability of the property will be acceptable provided the two plots are in such proximity as to comprise a readily marketable real estate entity.

202 *Service and Facilities.*

202–1 *Trespass.*

Each living unit shall be one that can be used and maintained individually without trespass upon adjoining properties. Paragraph 303–2.5 provides an exception to this requirement.

202–2 Utilities.

Utilities shall be independent for each living unit except that common services such as water, sewer, gas and electricity may be provided for living units under a single mortgage or ownership. Separate utility service shut-off for each unit shall be provided. For living units under separate ownership, common utility services may be provided from the main to the building line when protected by easement or convenant and maintenance agreement acceptable to HUD. Individual utilities serving a living unit shall not pass over, under or through another living unit unless provision is made for repair and maintenance of utilities without trespass or legal provision is made for permanent access for maintenance and repair of the utilities.

202–3 Other Facilities.

Other facilities shall be independent for each living unit except that common services such as laundry and storage space or heating may be provided for two living units under a single mortgage.

203 Site Conditions.

203–1 Hazards.

The property shall be free of those hazards which may adversely affect the health and safety of the occupants or the structural soundness of the improvements or which may impair the customary use and enjoyment of the property. The hazards can be toxic chemicals, radioactive materials, other pollution, hazardous activities, subsidence, flood, erosion, or others located on or off site.

203–2 Unforseen Conditions.

When special or unforeseen conditions exist or arise during construction, such as rock formations, unstable soil, high groundwater level, springs, etc., which necessitate precautionary measures, the HUD field office may require such corrective work to meet the special conditions.

204 Access.

204–1 Streets.

Each property, shall be provided with vehicular or pedestrain access from a public or private street. Private streets shall be protected by premanent easements.

204–2 Access to the Living Unit.

A means of access to each living unit shall be provided without passing through any other living unit.

204–3 Access to the Rear Yard.
204–3.1 Acceptable means of access to the rear yard shall be provided without passing through any other living unit.
204–3.2 For a row type dwelling, the access may be by means of alley, easement, passage through the dwelling, or other acceptable means.
205 Housing for Physically handicapped People.
205–1 Technical Standard.

Housing and facilities for physically handicapped people, whether one living unit or an entire project and including but not limited to specific interior features such a halls, kitchens, bathrooms, ramps, stairs, doors, windows, common, facilities such as laundries and meeting rooms, and site elements such as walkways, curb ramps and parking, shall comply with the American National Standards Institute Standard No. A117.1, specifications for making buildings and facilities accessible to and usable by physically handicapped people.

205–2 Program Instructions.

Housing for physically handicapped people and appropriate facilities are provided as required by the specific program applicable to the housing being developed.

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Chapter 3

Site Design

[300] [1] *General.*

A site design shall be provided which includes an arrangement of all site facilities necessary to create a safe, functional, healthful, durable living environment for residents.

301 *The Proposed Site.*

301–1 Topography.

In the design of a site the effect of topographic conditions on the costs of development and operation shall be considered when locating various uses on the land. Land uses shall be combined with site conditions in a manner which assures a functional, economically maintained development and in a manner which permits correction of potential hazards.

301–2 Ground Water.

Buildings, structures, streets, paved areas and utilities shall be located on the site in areas of the least potential ground water hazard. These are areas of contained underground or perched water whose upper level provides a subsurface water table.

302 *Land Use.*

302–1 General.

Land use planning for residential developments shall recognize and relate to all on-site conditions.

[302–2] Intensity of Development.

The number, size and type of dwellings along with parking spaces, recreation and other open spaces shall be determined by the characteristics of the site, its location, land cost, and acceptability by the community.

[302–3] Noise Control.

Through the use of site design techniques such as building location and orientation, window placement and the use of barriers, predictable undesireable site noise shall be moderated to meet the requirements of 24 CFR Part 51, Environmental Criteria and Standards.

303 *Lots, Yards and Building Setback Distance.*

[303–1] General.

Yard depth and width shall be arranged to assure adequate distance between buildings. The length and height of each building wall; the location of the main entrance as it relates to the dwellings and to window walls of nearby dwellings; and the location of windows in all habitable rooms shall be considered in establishing yard depth.

303–2 Side and Rear Yards.

303–2.1 Yard space between exterior building walls and the adjacent lot line shall be measured prependicular to the lot line opposite the building wall at all points. The minimum distance from the wall to the lot line is determined by:

a. The height of the wall in stories;

b. The horizontal length of the wall from corner to corner;

c. The type of wall;

(1) *Primary Wall* is that wall which contains the principal window(s) in a habitable room, except bedrooms and kitchen; and/or the main entrance to the dwelling when it directly faces a primary wall of another dwelling.

(2) *Secondary Wall* is that wall which contains the window(s) of rooms for other than a primary wall as defined above.

(3) *Windowless Wall* is that wall which contains no windows.

303–2.2 Min. distance from building wall to lot line:

a. Primary wall.

6 ft plus 2 ft for each story (S) in height plus 1 ft for each 10 ft of length (L). $D = 6 + 2S + L/10$.

For [ ] See Note 1 on page 3–3.

b. Secondary Wall.

2 ft + 1 ft for each story (S) in height plus 1 ft for each 10 ft of length (L), min. distance 5 ft. $D = 2 + S + L/10$.

c. Windowless Wall.

(1) Dwelling.

1 ft for each story (S) in height plus 1 ft for each 10 ft in length (L), min. distance 5 ft. $D = S + L/10$.

(2) Detached Carport or Garage.

1 ft for each story (S) in height plus 1 ft for each 10 ft in length (L). Min. distance 3 ft. $D = S + L/10$.

d. Retaining Wall.

The distance between a building wall with habitable room windows and a retaining wall with the top above the midpoint of the vertical height of the lowest window shall be a min. of the sum of the side yard distances of the two wall, see above, treating the retaining walls as a windowless wall.

[303–2.3] In single family detached living units, min. distance from side and rear lot lines for all building walls shall be not less than 5 ft except as permitted in 303–2.5.

[303–2.4] For single family detached living units to be placed on existing lots with buildings on adjacent lots, no lot line set back is required. Minimum required building separation is 10 ft. Legal provision shall be made for permanent

[1] Paragraphs in Chapter 3 of 4900.1 with numbers or letters shown in brackets thus [000–00] shall be the only applicable site design requirements for single family detached houses within the property lines of individual lots on existing streets with utilities.

access for the maintenance of the exterior portion of the proposed building wall.

[303–2.5] *Zero Side Yard.*

Location of the windowless wall of a detached dwelling on a side lot line is acceptable to HUD providing that:

[a.] legal provision is made for permanent access for the maintenance of the exterior portion of the lot line wall, and

(b.) the minimum distances from the dwelling to the dwellings on the abutting properties are not less than the sum of the side yard distances computed as appropriate for the type of opposing walls. (Min. distance 10 ft).

303–2.6 *Vertical Setback.*

Where the length of a wall is angled or setback 6 ft or more, the length (L) of each segment or plane is measured separately in determining the required yard depth.

303–2.7 *Horizontal Setback.*

Where there are horizontal setbacks or overhangs in a multistory building wall, the height of each window wall is measured from the first floor of the building to the top of the wall under consideration.

(303–2.8) *Projection into Yard Areas.*

The projection of open balconies, bay windows and uncovered porches into the open space is acceptable.

(303–2.9) *Roof Overhang.*

Where adjacent buildings have roof overhangs the minimum distance between the edge of the overhang shall be 6 ft, except where both buildings are detached garages, where the minimum distance may be 4 ft.

(303–2.10) *Building Slope Setback.*

Where minimum slopes away from foundations terminate at the toe of a 2 on 1 or steeper slope, yard area dimensions from the building wall to the toe of the slope shall be increased 1 ft for each 4 ft of slope height above 15 ft.

303–3 *Distance Between Buildings.*

303–3.1 The distance between buildings shall not be less than the sum of the yards of the individual wall types required by section 303–2.2.

(303–3.2) Min. distance between a dwelling and an accessory building on the same plot, at any point shall be 10 ft, except:

(a.) where no required windows are located in opposing walls, 5 ft minimum;

(b.) minor passage ways (10 ft max. length), no windows located in opposing walls, 3 ft min.

(303–4) Building Parking Setback Distance.

Buildings with grade level or low windows shall be set back from parking areas and shall be arranged to prevent direct or concentrated discharge of automobile exhausts into any window.

303–5 Courts.

(303–5.1) *Outer Courts.*

(a.) The width of outer courts, bounded on three sides by building walls or potential building walls, shall not be less than the sum of the required yard distances measured from opposing building walls. See 303–2.2.

(b.) Where the depth of a court is less than half the width, the min. width may be reduced 25 percent.

(c.) For buildings located on courts having a wall or walls not parallel to the property line, applicable yard distance measurements shall be from the narrowest point.

(d.) The depth of a court shall not be greater than one and one half times the width.

(303–5.2) *Inner Courts.*

(a.) Inner courts formed on four sides by building walls or potential building walls, shall have a minimum dimension equal to the sum of the required yards but not less than 10 ft. Their areas shall not be less than 100 sq ft for one story or 150 sq ft for two stories or more.

(b.) An unobstructed passageway shall be provided at grade level of each inner court serving more than 1 living unit. Such passageways shall have a cross section not less than 4 ft wide by 7 ft high to permit the passage of non-vehicular fire fighting equipment and shall be continuous from the inner court to a yard, or an unobstructed open area between buildings.

(c.) Inner court design shall be arranged to permit use of fire ladders and equipment.

(d.) Where all the walls of an inner court are formed by the same one story living unit minimum dimensions based on the sum of the side yard distances do not apply. The minimum distance between walls shall be as shown in 303–2.2 disregarding the 5 ft minimum distance in sections b. and c.

304 *Streets.*

304–1 General.

304–1.1 Existing or proposed streets on the site shall connect to private or public streets and shall provide all weather access to all residential and other buildings for essential and emergency use, including access needed for deliveries, service, maintenance, fire equipment, and car parking facilities.

304–1.2 Streets shall be designed for dedication for public use and maintenance or, when approved, may be retained as private streets where protected by permanent easements on the property.

304–1.3 The width and construction of the required street and provisions for its continued maintenance shall provide a safe and suitable vehicular access to and from the property at all times.

304–2 Location.

304–2.1 Arterial and collector streets shall be located to provide the principal traffic ways for a development and as required for compliance with the comprehensive plan for the area. Direct access to properties from major arterial streets and highways shall be avoided. Access to properties shall be designed to minimize all traffic hazards.

304–2.2 Driveways, courts, culs-de-sac, loops and minor streets shall be designed to provide access to residential properties.

304–2.3 Street design shall be adapted to the topography to assure surface drainage with reasonable flow velocity and the proper functioning of storm and sanitary sewers.

304–3 Width.

304–3.1 Street and driveway widths shall be designed to accommodate all anticipated vehicular traffic, and where required, on-street parking.

304–3.2 Minimum pavement width:

a. traffic lane—9 ft.

b. parking lane—8 ft.

304–4 Turn Arounds.

304–4.1 Safe and convenient turning space shall be provided for cars, service trucks and where appropriate, fire fighting equipment, at the end of dead-end streets and courts. The design shall assure turning space without interference by parked cars.

304–4.2 Minimum paved diameter of a turning circle—80 ft. When located on land with 15% or steeper grades, turning circles with no parking and serving culs-de-sac with 20 or less living units may have a paved diameter of less than 80 ft but not less than 60 ft.

Minimum paved width for a "T" turnhead—60 ft.

304–4.3 Streets which extend more than 150 ft from an intersection to provide access to an abutting undeveloped property shall be provided with a temporary "T" turn abutting the undeveloped property.

304–5 Intersections.

304–5.1 Street design shall locate intersections to assure safe sight distances considering the characteristics of anticipated traffic.

304–5.2 Intersections of more than two streets are unacceptable and T intersection offsets of less than 125 ft are not acceptable where they can be avoided.

304–6 Undedicated Streets (Public Driveways).

304–6.1 On-site driveways or undedicated streets shall enter public streets at safe locations, see 304–5. Such streets terminating in a cul-de-sac or court shall have an adequate turning space, see 304–4.

304–6.2 Min. width is the same as for streets, see 304–3.

304–7 Private Drives.

[304–7.1] Drives shall extend from the street or alley surfacing to the garage, carport or parking space. The location, alignment, and grades shall be designed to provide for save and convenient use.

[304–7.2] Min. width 8 ft drive shall have 5 ft radii or shall flare to 14 ft width at street entrance.

305 *Parking Areas.*

305–1 General.

Adequate parking space shall be provided for residents, guests and service vehicles. Where practical, additional parking space shall be planned and reserved for future use.

305–2 Number of Spaces.

[305–2.1] The number of parking spaces required for each living unit shall comply with the Land Use Intensity criteria or with other standards acceptable to HUD.

305–2.2 Parking Spaces for Physically Handicapped People Shall be in Accordance With ANSI A117.1.

305–3 Parking Location.

[305–3.1] One parking space shall be provided for each living unit on each lot except where permanent parking for occupant use is provided in courts, bays, garages or carports where maintenance is assured. Where a garage is not provided on the lot the minimum parking space shall be adequate for a full sized car.

[305–3.2] The required parking for each dwelling beyond the first car is acceptable on minor streets within and abutting the property. They shall have sufficient width, see 304–3, to accommodate parked cars without interference with normal traffic. Such spaces are countable as required parking when permitted by local ordinances and when their long term use for this purpose can be expected.

[305–3.3] *Safe Sight Distance.*

All parking facilities shall be arranged so that drivers have a clear view of approaching pedestrians and vehicles when crossing walks and entering traffic lanes.

305–4 Parking Bays.

305–4.1 The location of parking bays shall be limited to culs-de-sac, loops or other minor streets where fast moving traffic will not be a hazard.

305–4.2 Min. single space dimension—8 ft. wide and 18 ft. deep. Max. number of spaces in a single bay—20.

305–5 Parking Courts.

305–5.1 Entrance, exit and court shall be designed to prevent fast travel and discourage through traffic.

305–5.2 Parking space size and court dimension shall be the same as for parking bays, see 305–4.

305–6 Wheel Stops.

Wheel stops, or other appropriate barriers shall be provided and suitably placed to prevent unwanted vehicular encroachment beyond parking area limits.

306 Walks.

306–1 General.

[306–1.1 Walks shall be provided for safe, convenient access to all dwellings and for safe pedestrian circulation throughout a development between facilities and locations where major need for pedestrian access can be anticipated.

[306–1.2] Walks shall be located to assure a min. vertical clearance of 7 ft. from all permanent or temporary obstructions.

[306–1.3] Walks and step treads shall have a slip resistant surface.

306–2 Public or Common Use Walks.

306–2.1 Walks shall be provided for all dwellings having frontage on highways or collector streets and where essential for pedestrian safety.

306–2.2 Min. walk width shall be 4 ft. except abutting a parking bay or court where it shall be 6 ft. to accommodate car overhangs and provide walking space.

306–3 Entrance and Service Walks.

[306–3.1] An entrance walk shall extend from the front entrance of a dwelling to the drive, street or common walk.

[306–3.2] Min. entrance walk width, 3 ft.

306–3.3 Entrance Walks for the Physically Handicapped Shall be in Accordance With ANSI A117.1.

306–4 Exterior Steps Not Attached to Dwelling.

306–4.1 *General.*

Steps and stepped ramps shall be provided only where walks would exceed gradient limitations and be unsafe or impractical and shall be as wide as the walk in which they are located. The rear intersection of treads and risers shall be at least 2 in. above grade unless treads are otherwise premanently protected from siltation and debris.

[306–4.2] *Flight.*

a. Single steps are not acceptable.

b. A min. flight for stepped ramps shall consist of 3 single risers or 2 pairs of risers.

c. Steps shall be set back from an intersecting walk or drive a min. of one foot at a retaining wall and two feet at slopes.

[306–4.3] *Riser and tread.*

a. Riser, max. 6 in., min. 3 in., uniform throughout flight.

b. Tread, min.:

(1) Steps, 12 in., uniform throughout flight.

(2) Stepped ramp, 2 easy paces between single risers, 1 or 3 easy paces between two risers.

c. Treads shall have a slip resistant surface.

d. Treads shall be pitched appropriately to insure drainage.

[306–4.4] *Landing.*

[a.] Min. length shall equal 3 ft or walk width whichever is greater.

[b.] A change in direction in a flight of stairs shall be accomplished only at a landing or by a winder which has a tread width at a point 18 in. from the converging end, equal to the full straight stair tread width.

[306–4.5] *Handrails.*

a. Stairways having a flight rise exceeding 30 in. shall have a handrail located on one side for stairs 5 ft or less in width and on both sides of stairways over 5 ft wide.

b. In housing for the elderly, handrails shall be provided in accordance with ANSI A117.1 on both sides of a tenant stairway with a flight rise exceeding 24 in. and width exceeding 4 ft, and on one side when the width is 4 ft or less.

307 *Utilities.*

307–1 General.

[307–1.1] No part of a residential structure shall be located less than 10 ft from the outer boundary of the pipelines easement of high pressure gas and liquid petroleum transmission lines which are installed in accordance with Code of Federal Regulation Title 49, Parts 192 and 195. Attached garages, carports, utility rooms, etc., or places of assembly shall be considered a part of the residential structure for purposes of this standard.

[307–1.2] The site design shall be arranged to recognize existing easements, utility lines, etc., and permit connection to existing facilities where necessary for the proper functioning of drainage and utilities.

307–2 Dedication.

Utilities shall be located to permit dedication to the local government or appropriate public body for operation and maintenance.

308 *Services.*

[308–1] General.

Necessary services supplied by the local community shall be provided the required space to permit economical operation and maintenance.

308–2 Garbage and Refuse.

[308–2.1] Space for refuse can storage shall be provided adjacent to each living unit.

308–2.2 Collection stations serving groups of one and two family dwellings shall be provided only when permanent maintenance is assured.

308–2.3 Single container stations where provided to serve groups of dwelling units shall be in locations designed to accommodate collection vehicle functions.

308–2.4 *Outside Incinerators.*

The design of incinerators shall be approved by and in accordance with appropriate local or state authority and the standards of the Air Quality Control Regions created under the Clean Air Act of 1967.

309 *Grading Design.*

309–1 General.

[309–1.1] Site grading shall accomplish the following:

[a.] Allow drainage of surface water away from buildings and off-site;

[b.] Minimize earth settlement problems;

[c.] Avoid concentrating runoff onto neighboring properties where erosion or other damage will be caused;

[d.] Minimize erosion.

[309–1.2] Site grades shall be designed for the disposal of surface water by infiltration into the ground only where year-around feasibility of this method has been proven for the site.

[309–1.3] Ground settlement around foundation walls, utility trenches or other filled areas shall not interfere with work drainage away from the house.

309–2 Natural Topography.

[309–2.1] Grading design shall use natural drainage ways for drainage where possible and shall not cause or increase erosion conditions within or adjoining the site.

[309–2.2] Grades shall be designed to retain original ground surface levels to the limits of the branch spread of trees and around other natural vegetation to be preserved in place.

[Table 3-9.1]

GRADIENTS PERCENT (1)

ACCESS AND PARKING	Min. CENTER LINE	Min. CROWN OR CROSS SLOPE	Max. CENTER LINE	Max. CROWN OR CROSS SLOPE
STREETS (2)	0.5%	1.0%	14.0%	5.0%
STREET INTERSECTIONS (2)	0.5%	1.0%	5.0%	5.0%
DRIVEWAYS (3)	0.5%	1.0%	14.0%	5.0%
WALKS (4)				
Concrete		0.5% (10)		
Bituminous		1.0%		
Building Entrances & Short Walks	1.0%		12.0%	5.0%
Main Walks	0.5%		10.0%	5.0%
Adjoining Steps			2.0%	
Landings		1.0%		2.0%
Stepped Ramp Treads	1.0%		2.0%	
PARKING		0.5%	5.0%	5.0%

SLOPE GRADIENTS

SLOPE AWAY FROM FOUNDATIONS		
Pervious Surfaces	5.0% (5)	21.0% (7)
Impervious Surfaces	1.0% (5)	21.0% (7)
Slope to upper end of a drainage swale	2.5% (5) (6)	
PERVIOUS SURFACES		
Ground Frost Areas	2.0%	
Non-Ground Frost Areas	1.0% (8)	
IMPERVIOUS SURFACES	0.5%	
USABLE OPEN AREA		5.0%
OTHER AREAS (9)		50.0% (2:1)
Slopes to be maintained by machine		33.0% (3:1)

Notes for Table 3-9.1:

(1) Approximate Equivalents .5% = 1/16"/ft., 1.0% = 1/8"/ft., 2.0% = 1/4"/ft., 5.0% = 5/8"/ft., 10.0% = 1 1/4"/ft., 12.0% = 1 1/2"/ft., 21% = 2 5/8"/ft.

(2) Do not apply to development on lots for single family detached dwellings.

(3) Vertical transitions shall prevent contact of car undercarriage or bumper with driveway surface.

(4) 5.0% max. for major use by elderly tenants.

(5) Min. fall of protective slope around buildings 6 in., and 10 ft. length or as limited by property lines.

(6) Can be used only where no steep adjacent slopes will contribute storm runoff.

(7) Min. length 4 ft.

(8) Areas having annual precipitation of more than 50 in. use 2.0%.

(9) After individual analysis HUD field office may accept steeper slopes or require flatter slopes, see HUD Handbook "Slope Protection for Residential Developments", 4075.7.

(10) For walks abutting foundations, min. cross slope 5% in areas subject to major frost problems.

[309-3] First Floor Grades.

First floor grades shall be established which will:

[309-3.1] Avoid deep cuts and fills;

[309-3.2] Allow gravity sanitary sewer service to be provided to first floor levels and to basements from street mains unless otherwise acceptable to the HUD field office;

[309-3.3] Avoid the need for long or repeated flights of steps;

[309-3.4] Minimize the need for banks, retaining walls or terracing.

[309-4] Streets, Parking and Walks.

The overall grading design shall be arranged to assure safe all-weather pedestrian and vehicular access to dwellings and to all other necessary site facilities, see Table 3-9.1.

309-5 Slopes.

[309-5.1] Grades shall not be designed which direct a concentrated flow of surface drainage over existing or proposed slopes.

[309-5.2] All earth slopes with grades of 3 on 1 or steeper shall be planted with appropriate vegetative cover to minimize erosion.

[309-5.3] Existing slopes whose continuing stability is anticipated and which are covered by vegetation or supported by solid rock out-cropping are acceptable.

[309-5.4] Occupant and visitor exposure to potential hazards such as rock slides or steep cliffs, shall be minimized by the installation of fences, walls or planting, as appropriate.

[309-6] Lawns.

[309-6.1] Lawn preparation shall include a surface layer having a min. depth of 4 in. comprised of surface soil with a known local capability of satisfactorily supporting lawn growth.

[309-6.2] Sodded areas shall have a min. finished depth of 4 in. of sod and surface soil with a known local capability of satisfactorily supporting lawn growth.

[309-6.3] Grading for secondary lawn areas, see 311-2.2, shall be kept to the min. necessary to prevent standing water or other undesirable moisture conditions.

310 *Drainage.*

310-1 General.

[310-1.1] Surface and subsurface drainage systems shall be provided, as appropriate, for collection and disposal of storm drainage and subsurface water. These systems shall provide for the safety and convenience of occupants, protection of dwellings, other improvements and usable lot areas from water damage, flooding, and erosion.

[310-1.2] Where storm drainage flow is concentrated, permanently maintainable facilities shall be provided to prevent significant erosion and other damage or flooding on site or on adjacent properties.

[310-1.3] Necessary grades and swales shall be constructed to insure surface drainage away from the house. Standing water shall not remain in the yard longer than 24 hours after a rain except in swales which may drain as long as 48 hours after a rain or discharge of a sump pump. Grading determination shall not be made when there is frost in the ground.

310-2 Drainage Design and Flood Hazard Exposure.

[310-2.1] Drainage shall be designed to accommodate storm runoff calculated on the basis of ultimate forseeable developed conditions of contributory site and offsite drainage areas.

[310-2.2] The minimum grades at buildings and at openings into basements shall be at elevations which prevent adverse effect by water or water entering basements from flood levels equivalent to a 50 year return frequency. The floor elevations of all habitable space shall be above flood levels equivalent to a 100 year return frequency.

[310-2.3] Provide the best available routing of runoff water to assure that buildings

or other important facilities will not be endangered by the path of major emergency flood runoff which would become active if the capacity of the site storm drainage system is exceeded.

310–2.4 Streets shall be usable during runoff equivalent to a 10 year return frequency. Where drainage outfall is inadequate to prevent runoff equivalent to a 10 year return frequency from ponding over 6 in. deep, streets shall be made passible for local commonly used emergency vehicles during runoff equivalent to a 25 year return frequency except where an alternate access street not subject to such ponding is available.

[310–2.5] Site drainage shall be routed to permanent surface or subsurface outfall adequate to dispose of present and future anticipated runoff from the site and from contributing offsite water shed areas except where such water is necessary for controlled irrigation.

[310–2.6] Drainage swales shall not carry runoff across walks in quantities which make them undesirable to use. Walks shall not be designed as drainage ways.

[310–2.7] Developed portions of a site which can be adversely affected by a potentially high ground water table shall be drained where possible by subsurface drainage facilities adequate for the disposal of excess ground water.

[310–2.8] Storm drainage pipe shall be sized to accept potentially imposed loads without failure.

310–3 Primary Storm Sewer.

310–3.1 Pipe size for the primary storm sewer (any storm sewer or inlet lateral located in a street or other public right-of-way) shall have an inside diameter based on design analysis but not less than 15 in. Where anticipated runoff from the five year return frequency rainfall will not fill a 15 in. pipe, primary storm sewer system usually is unnecessary.

310–3.2 The minimum gradient shall be selected to provide for self-scouring of the conduit under low-flow conditions and for removal of sediments foreseeable from the drainage area.

310–4 Secondary Drains.

Provide pipe drains of adequate size from minor runoff concentration points connected to appropriate disposal lines when analysis indicates the need.

[310–5] Drainage Swales, and Gutters.

Paved gutters shall have a minimum grade of 0.5 percent. Paved gutters and unpaved drainage swales shall have adequate depth and width to accommodate the maximum foreseeable runoff without overflow. Swales and gutters shall be seeded, sodded, sprigged or paved as appropriate to minimize potential erosion.

310–6 Open Channels.

[310–6.1] Channels shall be protected from erosion by appropriate vegetative cover, lining or other treatment indicated as necessary by analysis.

310–6.2 Earthen channel side slopes shall be no steeper than 2 to 1 and shall be flatter to prevent erosion where analysis indicates the need.

310–6.3 Open channels with lining shall have a maximum gradient on side slopes of 67.0 percent (1½:1), with adequate provisions for weep hole drainage. Channel side slopes steeper than 67.0 percent shall be designed as structural retaining walls with provision for live and dead surcharge load.

310–7 Downspouts.

[310–7.1] Downspouts shall either be connected to available storm sewer, provided with suitable splash blocks or empty at acceptable locations onto paved areas so that water drains away from buildings.

[310–7.2] Splash blocks shall be constructed of concrete or other durable material.

310–8 Storm Inlets and Catch Basins.

310–8.1 All storm inlets and catch basins shall be adequate in size and design to accept and carry the calculated potential runoff without overflow.

310–8.2 All storm inlets and catch basins shall be constructed of durable materials which will not erode and will accept potentially imposed loads without failure.

310–8.3 Where inlets are accessible to small children, openings shall have one dimension limited to a max. of 6 in.

310–8.4 Access for cleaning shall be provided to all inlet boxes and catch basins.

310–8.5 Where inlets are located in areas of potential pedestrian use, the design of openings and exposed surfaces shall be arranged to minimize the dangers of tripping or slipping.

310–8.6 Horizontal inlet openings in paved areas shall be designed to avoid entrapment or impedence of bicycles, baby carriages, etc.

310–9 Manholes and Junction Boxes.

Manholes and junction boxes shall be spaced at optimum intervals as indicated by analysis and shall be provided where there is a particular hazard of blockage, at abrupt changes in alignment, and at junctions with mains and principal laterals.

310–10 Headwalls.

Headwalls and other appropriate construction shall be placed at the open ends of storm sewers to prevent excessive erosion and undermining of conduit.

310–11 Drywells.

[310–11.1] Drywells for the disposal of water from foundation drains, crawl spaces, and other small quantity sources, are permissible only where the bottom of drywells project into strata of undisturbed porous soil at a level where the bottom of the drywell will be above the ground water table at its highest seasonal elevation.

310–11.2 Drywells shall be placed a min. distance of 20 ft from buildings. This distance may be reduced to 10 ft if the dry well does not exeed 3 ft in diameter.

311 *Planting.*

311–1 General.

311–1.1 Planting shall coordinate appropriate new plant materials and their ecological requirements with the climate, soil, orientation, water courses, existing vegetation, related natural resources and man-made facilities.

311–1.2 Plantings at intersections or driveway entrances shall allow a permanently clear safe site distance for all vehicles.

311–2 Required Coverage.

[311–2.1] For slopes and swales see [309–5.2] and [310–5].

[311–2.2] Provide appropriate vegetative cover and/or preventative treatment for erosion and siltation by wind and water and for other areas as follows:

a. Tenant occupied properties and common use area—disturbed ground area.

b. Owner occuped property—as individually determined by the HUD field office considering local custom and practice or to prevent erosion and siltation as needed.

311–3 Lawns.

[311–3.1] Primary lawns, essential to the use and appearance of a home or development and usually intended for regular mowing, shall be planted according to good local horticultural practices with locally acceptable lawn grasses in a manner which results in a satisfactory stand of permanent grass. Where the area is not to be mowed, an acceptable permanent ground cover may be used.

[311–3.2] Secondary lawns, large open spaces maintained as meadows and occasionally mowed or rear areas of developments where fine quality lawns are of secondary importance, shall be planted with vegetation appropriate to the location and intended use.

[311–4] Ground Cover.

Ground cover plants shall be of good quality, appropriate form, growth habit and ultimate size to fulfill intended use.

312 *Site Details.*

312–1 General.

Paved pedestrian areas shall have slip resistant finishes.

312–2 Walls and Fences.

[312–2.1] Walls and fences shall be included in the site design as appropriate to provide safety, noise reduction or grade transition. For loading design criteria, see 601.

[312–2.2] Guard rails or other suitable barriers shall be provided on accessible retaining walls or at other locations which, because of the height (24 in. or over) or other factors, constitute a hazard to life safety.

312–3 Outdoor Lighting.

All public areas where pedestrian use can be anticipated after sunset shall be adequately lighted for security purposes where arrangements for permanent maintenance and operation can be assured. Minimum levels of illumination in footcandles for the following areas shall be: building entrances 4, commercial area walks and heavy use walks 2, steps and hazardous areas 2, parking areas 1, other public walks and common areas for pedestrian use 2.

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Chapter 4.—Building Design

400 *Space Planning.*
400–1 General.
400–1.1 In projects designed for both elderly and for families with children, indoor and outdoor community facilities for elderly shall be separated from those for families with children.
4001.2 Housing and Facilities for Physically Handicapped People Shall Comply With ANSI A117.1.
400–2 Non-Residential Spaces.
400–2.1 *Community Social Rooms.*

Where community social and receational rooms are provided, they shall be designed in accordance with the needs of the occupants and shall have adjacent toilet facilities for men and women. An adjacent storage area shall be provided. Community facilities accessible to physically handicapped people shall comply with ANSI A117.1.

400–2.2 *Management and Maintenance Space.*

Space, if provided, shall be commensurate with the number of dwellings served. Also, space shall be provided for necessary staff where social services are provided.

400–2.3 *Common Laundries.*

a. Common laundry facilities containing space for automatic washers, dryers and sorting tables shall be centrally located for the convenience and safety of the users. The space within the laundries shall be visible from an adjacent public area.

b. Laundry Facilities Serving One or More Living Units for Physically Handicapped People Shall Comply With ANSI A117.1.

400–2.4 *Project Storage.*

Space for storage of maintenance supplies and equipment such as paint, hand tools, lawn mowers, snow blowers, etc. shall be provided in accordance with the needs of the project.

400–2.5 *Facilities for Trash and Garbage Disposal.*

Provide for the temporary sanitary storage of trash and garbage and for its subsequent disposal or removal.

400–2.6 Optional Project Facilities in Housing for the Elderly.

Where the following facilities are provided, they shall comply with the following:

a. Occupational or Physical Therapy—Provide space for services and for storage of equipment.

b. Dietitian's Office—When a dietitian is to be employed, provide suitable office space convenient to the kitchen.

c. First Aid or Health Room—These facilities and any accompanying infirmary shall be designed for observation, minor treatment, or short-term care of project residents. When these services are provided, facilities for an attending nurse are required.

d. Nursing Facilities—Designed for either short-term or long-term care for project residents shall be as follows:

(1) Facilities may be provided initially within the project or by residential units specially designed for conversion to nursing facilities at a later date.

(2) The nursing unit and patient rooms shall comply with requirements of the Minimum Property Standards for Care-Type Housing.

(3) The nursing portion of the project shall be clearly incidential to the purpose of providing housing, and the ratio of nursing beds to living units shall not exceed 1 to 4.

e. Medical Facilities—Where a project doctor's office with examination and treatment rooms is provided, it shall be designed to serve only project residents. Spaces provided for rental to doctors, dentists, oculists, opticians, etc., shall be within the limits of allowable commercial space and located so as not to interfere with the residential space.

f. Central Dining—Space is required to provide meals for the occupants of living units which do not contain cooking and dining facilities. Seating and circulation space for the number of persons to be served at one time shall be provided on the basis of the following table and chair sizes:

Table for four persons, 2'–6" x 3'–2" or 3'—0" x 3'—0"

Table for six persons, 3'–4" x 4'–0" or 4'–0" round

Dining chairs, 1'–6" x 1'–6", wheelchairs, 2'–1" x 3'–6½"

g. Central Kitchen Facilities—are required where central dining is provided. The kitchen shall be arranged and equipped for adequate and efficient food storage, preparation in proper sequence, serving, dish and utensil cleaning and storage, and refuse storage and removal. Except in small installations (under 20 living units), the dishwashing activity shall be separated from that of food preparation. All cabinets and equipment provided shall be designed and installed to prevent contamination by insects, rodents, other vermin, splash, dust and overhead leakage.

400–3 Room Sizes.
400–3.1 Every dwelling shall have at least one habitable room which shall have not less than 150 sq ft of floor area. Other habitable rooms shall have an area of not less than 70 sq ft; except every kitchen shall have not less than 50 sq ft of floor area; *except in housing for the elderly, a 72 in. compact kitchen with wall cabinets and with refrigerator not below the countertop may be used.*
400–3.2 Habitable rooms except kitchens shall be not less than 7 ft in any horizontal dimension.
400–4 Kitchen.
400–4.1 Each dwelling unit shall be provided with a kitchen area and every kitchen area shall be provided with a sink of approved nonabsorbent material.
400–4.2 A range burner shall not be located under a window nor within 12 in. of a window. Where a cabinet is provided above a range, 30 in. clearance shall be provided to the bottom of an unprotected cabinet, or 24 in. to the bottom of a protected cabinet.
400–4.3 Kitchens for Physically Handicapped People Shall Comply With ANSI A117.1.
400–5 Baths.
400–5.1 Every dwelling unit shall be provided with a water closet, lavatory and a bathtub or shower.
400–5.2 *Toilet, Bath and Shower Compartments.*

a. Every water closet, bathtub or shower shall be installed in a room which will afford privacy to the occupant.

b. Each water closet compartment shall be not less than 30 in. in width and there shall be not less than 21 in. clear space in front of each water closet.

c. Shower compartment floors and walls shall be finished with a hard and nonabsorbent surface to a height of not less than 6 ft above the floor.

d. Additional requirements for housing for the elderly.

(1) Bathtubs shall be at least 5 ft long and shall be provided with at least two grab-bars.

(2) A stall shower with a seat and grab-bars may be provided in lieu of a bathtub.

(3) Tub or shower bottom surfaces shall be slip resistant.

(4) Grab-bars shall be installed to sustain a dead weight of 250 lbs for 5 minutes.

e. Bathrooms for Physically Handicapped People Shall Comply With ANSI A117.1.

400–6 Laundry.
400–6.1 Where common laundry is not furnished, provide space in each living unit for a clothes washing machine equipped with power supply and water and waste piping or a laundry tray.
400–6.2 Where drying facility is furnished, vent to the outside.
400–6.3 Laundry Facilities in Living Units for Physically Handicapped People Shall Comply With ANSI A117.1.
400–7 Private Garages and Carports.
400–7.1 Openings from a private garage directly into a room used for sleeping purposes shall not be permitted. Other openings between the garage and residence shall be equipped with solid wood doors not less than 1⅜ in. in thickness or equivalent.
400–7.2 The garage shall be completely separated from the residence and its attic area by means of ½ in. gypsum board or equivalent applied to the garage side.

400–7.3 Garage and carport floor surfaces shall be of approved noncombustible material.

400–7.4 Private Garages and Carports for Physically Handicapped People Shall Comply With ANSI A117.1.

400–8 Ceiling Heights.

400–8.1 Habitable rooms shall have an average of not less than 7 ft 6 in. in at least 50 percent of their required area with no portion less than 5 ft in height.

Exception: Beams and girders spaced not less than 4 ft on center may project not more than 6 in. below the required average ceiling height.

400–8.2 All other rooms including kitchens shall have a ceiling height of not less than 7 ft. Hallways and corridors shall have a ceiling height of not less than 6 ft 10 in. measured to the lowest projection from the ceiling.

401 *Access and Circulation.*

401–1 Entrance Facilities.

401–1.1 In housing for the elderly, a foyer or vestibule shall be provided at all living unit entrances opening directly to the exterior where customary in cold climates.

401–1.2 The Entrance to Housing and Facilities for Physically Handicapped People Shall Comply with ANSI A117.1.

401–2 Doors and Openings.

401–2.1 *Exits*

a. Not less than one exit shall be provided from each dwelling unit.

b. Every sleeping room shall have at least one operable window or exterior door approved for emergency egress. The units must be operable from the inside to a full clear opening without the use of separate tools. Where windows are provided as a means of egress, they shall have a sill height of not more than 44 in. above the floor.

c. All egress windows from sleeping rooms must have a minimum net clear opening of 5.7 sq ft. The minimum net clear opening height dimension shall be 24 in. The minimum net clear opening width dimension shall be 20 in.

Exception: Grade floor window may have a net clear opening of 5 sq ft.

d. Where storm windows, screens or burglar guards are used, they shall be readily openable from the inside, without use of tools, to the required dimension.

e. The required exit door shall be a side-hinged door not less than 3 ft in width and 6 ft 8 in. in height.

f. Doors in Living Units for Physically Handicapped People Shall Comply With ANSI A117.1.

401–2.2 *Public Doors.*

a. Minimum widths of public doors shall be:

Main entrance to building—3′–0″ for double doors.

Secondary public entrance to bldg.—3′–0″.

Service entrance to building—2′–8″.

Public stairway—3′–0″.

b. Doors in Common Facilities Accessible to Physically handicapped People Shall Comply With ANSI A117.1.

401–2.3 Locking devices at doors and windows shall be as follows:

a. Each exterior doorway or doorway leading to garage areas, common hallways, terraces, balconies, or other areas affording easy access to the premises, shall be protected by a door which, if not a sliding door, shall be equipped with a dead lock using either an interlocking vertical bolt and striker, or a minimum ½ in. throw dead bolt, or a minimum ½ in. throw self-locking dead latch. Locks shall not require the use of a key for operation from the inside.

b. All sliding doors, first floor and basement windows, and windows opening onto stairways, fire escapes, porches, terraces, balconies, or other areas affording easy access to the premises, shall be equipped with a locking device. A sliding door used as a main or service entrance shall be equipped with a keyed locking device.

c. Locking Devices at Doors and Windows in Housing and Facilities for Physically Handicapped People Shall Comply With ANSI A117.1.

401–2.4 An access opening of 18 in. × 24 in. min. shall be provided to each crawl space and readily accessible attic access opening not less than 22 in. by 30 in. shall be provided to any attic area having a clear height of over 30 in. An access opening and accompanying areaway shall be of sufficient size and shape to permit replacement of any equipment located in an attic or crawl space.

401–3 Halls.

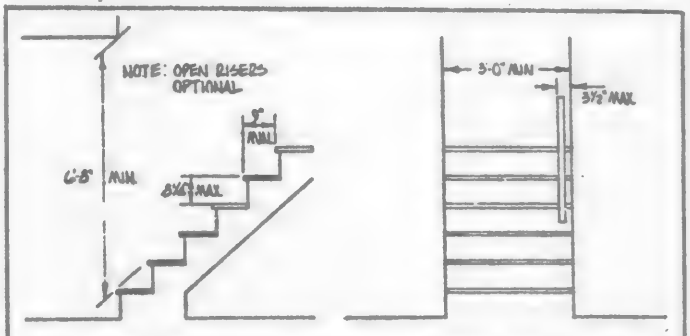
401–3.1 The minimum width of a hallway or exit access shall be not less than 3 ft.

401–3.2 Halls in Housing and Facilities for Physically Handicapped People Shall Comply With ANSI A117.1.

401–4 Stairways and Ramps.

401–4.1 Stairways shall not be less than 3 ft. 0 in. in clear width and the headroom, rise and run shall conform to Figure 4–1.1.

FIGURE 4–1.1 STAIRWAYS



"All treads shall have a nosing or effective projection of approximately one (1) inch. Treads and risers shall be so proportioned that the sum of two (2) risers plus one (1) tread, exclusive of nosing, is not less than twenty-four (24) nor more than twenty-five (25) inches."

401–4.2 Handrails may project from each side of a stairway a distance of 3½ in. into the required width.

401–4.3 Spiral stairways and winders are permitted provided the width of the tread at a point not more than 12 in. from the side where the treads are narrower is not less than 9 in. and the min. width is not less than 6 in.

401–4.4 Stairways and Ramps in Housing and Facilities for Physically Handicapped People Shall Comply With ANSI A117.1.

401–5 Landings.

401–5.1 A min. 3 ft by 3 ft landing shall be required on each side of an exit door.

Exception: At the top of an interior flight of stairs provided the door does not swing over the stairs.

401–5.2 The floor or landing shall not be more than 1½ in. lower than the top of the threshold.

Exception: The landing at the exterior side of an exterior doorway shall not be more than 7½ in. below the top of the threshold.

401–5.3 In Housing and Facilities for Physically Handicapped People, Landings Shall Comply With ANSI A117.1.

401–6 Handrails and Guardrails.

401–6.1 Handrails having min. and max. heights of 30 in. and 34 in., respectively, measured vertically from the nosing of the treads shall be provided on at least one side of stairways of 3 or more risers. Open sides of stairs with a total rise of more than 30 in. above the floor or grade below shall have guardrails not less than 30 in. in height measured vertically from the nosing of the treads.

401–6.2 Porches, balconies or raised floor surfaces located more than 30 in. above the floor or grade below shall have guardrails not less than 36 in. in height.

401–6.3 Handrails and guardrails on open sides of stairways shall have intermediate rails or ornamental closures which will not allow passage of an object 5 or more in. in diameter.

401–6.4 In Housing and Facilities for Physically Handicapped People, Handrails at Stairs and Ramps Shall Comply With ANSI A117.1.

402 *Light and Ventilation.*

402–1 Public Spaces.

Provision shall be made for lighting and ventilation of interior public spaces. The amount of illumination and ventilation shall comply with Table 4–2.1, see 616.*

TABLE 4–2.1

MINIMUM REQUIREMENTS FOR ARTIFICIAL AND NATURAL LIGHT NATURAL AND MECHANICAL VENTILATION

Location	Artificial Light Footcandles (5)	Nat. Light Glazed Area As % of Floor Area	Natural Ventilation, Opening As % of Floor	Mechanical Ventilation Air Changes Per Hour (1)
lobby (general)	10	—	5 or	4 supply(4)
dining (general)	15	10	—	6 supply
corridors	10	—	—(2)	4 supply(4,6)
stairs	10	—	5 or	4 supply(4)
laundries	20	—	5 or	6 exhaust
recreational areas				
arts and crafts	70	15	5 or	6 supply
game rooms (3)	20	—	5 or	6 supply

Notes to Table 4–2.1

(1) Central ventilating system.

(2) Corridors less than 30 ft in length may be ventilated by natural means in amount of not less than 5 percent of floor area.

(3) See Illuminating Engineering Society Lighting Handbook for other recreational areas not listed.

(4) Space shall not be used as supply or return air plenums for living unit ventilation.

(5) Measured 30 in. above the floor.

(6) Four changes may be reduced to 2 changes when all outside air is used. If 4 changes are used, air must be reconditioned.

402–2 Private Spaces.

402–2.1 All habitable rooms shall be provided with aggregate glazing area of not less than 8 percent of the floor area of such rooms. One-half of the required area of glazing shall be openable.

Exception: The glazed areas need not be openable where an approved mechanical exhaust system is provided capable of producing a change of air every 30 minutes and the opening is not required by 401–2.1.

402–2.2 Bathrooms, water-closet compartment and other similar rooms shall be provided with aggregate glazing area in windows of not less than 3 sq. ft., one-half of which must be openable.

Exception: The glazed areas are not required where artificial light and an approved room controlled mechanical exhaust system is provided capable of producing a change of air every 12 min.

402–2.3 Required glazed openings shall open directly onto a street or public alley, or a yard or court located on the same lot as the building.

Exception 1: Required glazed openings may face into a roofed porch where the porch abuts a street, yard or court and the longer side of the porch is at least 65 percent open and un-obstructed and the ceiling height is not less than 7 ft.

Exception 2: The glazed areas may be omitted in rooms where an approved mechancial exhaust system is provided capable of producing a change of air every 30 minutes (room controlled 100 cfm exhaust fan for kitchens), artificial light is provided capable of producing an average illumination of 6 ft candles over the area of the room at a height of 30 in. above the floor level, and the opening is not required by 401–2.1.

402–2.4 Clear inside projection at the center of an areaway shall be 12 in. min. If window is providing required natural light, increase this dimension one in. for each additional in. of vertical depth over 12 in. from top of areaway to window sill.

402–3 Underfloor Space.

402–3.1 The space between the bottom of the floor joists and the earth under any building (except such space as is occupied by a basement or cellar) shall be provided with a sufficient number of ventilating openings through foundation walls or exterior walls to insure ample ventilation, and such openings shall be covered with a corrosion-resistant wire mesh not greater than ½ in. nor less than ¼ in. in any dimension. The min. total free area of ventilating openings shall be proportioned on the basis of 2 sq ft for each 100 linear ft of crawl space area. One such ventilating opening shall be within 3 ft of each corner of said building.

Exceptions: a. Ventilation openings may be vented to the interior of buildings where warranted by climatic conditions; b. The total area of ventilation openings may be reduced to $\frac{1}{1500}$ of the underfloor area where the ground surface is treated with an accepted vapor retarder material, and c. Ventilation openings may be omitted on one side.

402–3.2 The underfloor grade shall be cleaned of all vegetation and organic material.

402–4 Attic Space.

402–4.1 Provide cross ventilation for each separate space by ventilating openings protected against the entrance of rain and snow.

402–4.2 Ratio of total net free ventilating area to area of ceiling shall be not less than $\frac{1}{150}$, except that ratio may be $\frac{1}{300}$ provided:

a. A vapor retarder having a transmission rate not exceeding one perm, and complying with 607–2.4b, is installed on the warm side of the ceiling, or

b. At least 50 percent of the required ventilating area is provided by ventilators located in the upper portion of the space to be ventilated (at least 3'–0" above eave or cornice vents) with the balance of the required ventilation provided by eave or cornice vents.

402–4.3 Attic space which is accessible and suitable for future habitable rooms or walled-off storage space shall have at least 50 percent of the required ventilating area located in the upper part of the ventilated space as near the high point of the roof as practicable and above the probable level of any future ceiling.

403 *Acoustic Control*

403–1 General

403–1.1 Living units shall be designed to provide an acoustically controlled environment in relation to exterior noise and noise from adjacent living units and public spaces.

403–1.2 If a site is normally unacceptable according to Title 24 CFR Part 51,

Subpart B—Noise Abatement and Control, the design of buildings for that site must consider exterior noise and provide for the necessary sound attenuation.

403–2 Sound Transmission Limitations

403–2.1 Mechanical equipment shall be located and installed to minimize transmission of objectional sound.

403–2.2 Living units shall be provided with acoustic separation in accordance with Table 4–3.1.

TABLE 4–3.1 – SOUND TRANSMISSION LIMITATIONS

LOCATION OF PARTITION	STC	
Separating living unit from other living units, common service areas or public spaces (average noise) (1)	45	
Separating living unit from public spaces or common service areas (high noise) (2)	50	
LOCATION OF FLOOR-CEILING	**STC**	**IIC**
Separating living units from other living units, public spaces or common service areas (1)	45	45
Separating living units from public spaces or common service areas (high noise) (2)	50	50

Notes:

(1) Public spaces of average noise include entries, stairways, etc.

(2) Areas of high noise include boiler rooms, mechanical equipment rooms, central laundries, and most commercial uses.

404 *Fire Protection*

404–1 Fire Resistance Requirements

Fire resistance ratings shall comply with Table 4–4.1 and shall be determined by ASTM E119 test. Where E119 test results of a similar type assembly are available as a bench mark, the judgement of a recognized fire testing laboratory or fire protection engineer, as to the fire rating, will be accepted in lieu of a specific test of the assembly.

TABLE 4–4.1 – MINIMUM FIRE RESISTANCE IN HOURS

Construction	Type of Housing	
	Detached and Semi-Detached	Row Houses Attached
Party, common walls	1	1-1/2(1)(2)
Exterior lot-line walls	3/4	3/4
Partitions at common entrance halls	3/4	3/4
Floors between living units	1(3)	1(3)
Exterior walls Bearing partitions Floor assemblies (5)(6) Roof assemblies (5)	1/3(4)	1/3(4)

Notes:

(1) Combustible walls which are penetrated with electrical outlets or other mechanical devices shall have interior (cavity) fire protection.

(2) Walls shall extend at least 18 in. above top of roof. See 404–4.1b for alternate methods.

(3) Supporting walls, beams and columns: 1 hr.

(4) Structural integrity only required and applies only to innovative construction. It is assumed that construction described in the MPS for these components will meet this requirement.

(5) Floor assemblies over nonhabitable basements, roof assemblies for detached and semi-detached housing, supporting beams and columns: ⅛ hr.

(6) Floor assemblies not meeting the ⅛ hr fire resistance rating will be acceptable where a single station smoke detector is provided for every level.

404–2 Heating Equipment

Stoves or combustion heaters shall not be located so as to block all means of egress from any room in case of a malfunctioning which could result in a fire.

404–3 Interior Fire Protection

404–3.1 *Party, Common and Lot-Line Walls*

a. Walls shall extend the full height of the dwelling without openings from the foundation to the top of the wall.

b. Walls separating row houses may be carried up to the underside of the roof sheathing and sealed tightly in the following conditions:

(1) Where the roof framing and deck are noncombustible and roof covering material at least Class C classification (ASTM E108).

(2) Where the roof construction provides one hour protection against sheathing burnthrough with a Class A brand (tested in accordance with Burning Brand Test of ASTM E108) for width of 6 ft on each side of the wall.

c. Plumbing and heating stacks may be placed in party, common and lot-line walls only where wall construction provides a minimum of one hr protection on each side of stacks. Penetration of the wall by electrical outlets or recessed cabinets shall not be back to back, and there shall be a minimum of one hr protection around penetration.

404–3.2 *Firestopping*

a. Concealed vertical spaces within walls and partitions shall be firestopped at each floor level and at the ceiling of the uppermost story.

b. Firestopping material shall be wood blocking of minimum 2 in. (nominal) thickness or of noncombustible materials providing equivalent protection.

404–4 Interior Finish—Flame Spread and Smoke Generated Limitations

404–4.1 *General.* Flame spread requirements for finishes shall not apply to trim defined as picture molds, chair rails, baseboards and handrails; to doors and windows or their frames; nor to materials which are les than 1/28 in. in thickness cemented to the surface of walls or ceilings, if these materials have flame spread characteristics no greater than paper of this thickness cemented to a noncombustible backing.

404–4.2 *Testing.* Tests shall be made in accordance with ASTM E 84 in order to arrive at flame spread or smoke density ratings.

404–4.3 *Flame spread.* The wall and ceiling surfaces of all rooms shall have a flame spread classification of not greater than 200.

404–5 Fire Alarm Systems

404–5.1 Smoke detectors, which may be a single or multiple station alarm device, shall be installed in each living unit outside of each separate sleeping area in the immediate vicinity of the bedrooms.

404–5.2 Smoke detectors shall be either the ionization chamber or the photoelectric type and shall comply with all the requirements of Underwriters Laboratories Standard No. 217. Single

and Multiple Station Smoke Detectors. Detectors shall bear the label of an independent inspection agency that indicates the smoke detectors have been tested and approved under the requirements of UL 217. The independent inspection agency shall be one which maintains a periodic follow-up service of the labeled devices to ensure compliance with the original approval.

404–5.3 All smoke detectors shall operate from the dwelling's electrical circuit. The detector mounting shall be permanently attached to an electrical outlet box and the detector wired into a general electrical circuit. There shall be no switches in the circuit to the detector other than the overcurrent protective device protecting the branch circuit.

404–6 Foam Plastics

404–6.1 *General.* Except where specifically exempted by subsection 2 below, foam plastics shall have a flame spread rating of not more than 75 and shall have a smoke developed rating of not more than 450 when tested in accordance with ASTM E 84 in the thickness intended for use.

404–6.2 *Specific requirements.* The following requirements shall apply to all uses of foam plastics in or on the walls, ceilings or both, or in attics, roof or floors, crawl spaces or similar areas.

a. Foam plastics may be used in the following locations:

(1) Within the cavity or on the exterior surface of a masonry or concrete wall.

(2) On the room side surface of conforming walls or ceiling or other surfaces, provided the foam plastic is fully protected from the interior of the building by a thermal barrier of ½ in. gypsum wallboard having a finish rating of not less than 15 minutes or other approved material having an equivalent finish rating. Thermal barriers shall be installed in a manner such that they will remain in place for a minimum of 15 minutes under the same test conditions.

(3) Trim, picture molds, chair rails, baseboards, handrails and show window backing may be of wood. Foam plastic trim covering not more than 10 percent of the wall or ceiling area may be used provided such trim has a density of no less than 20 pounds per cubic foot, has a maximum thickness of ½ in. and a maximum width of 4 in., and has a flame spread rating no greater than 75.

b. Foam plastics may be used as a roof covering if the foam plastic is a part of a Class A, B or C roofing assembly. That plastic foam which is nearest the interior of the building shall be protected by an approved barrier which need not have a 15-minute finish rating. Ordinary roof coverings, other than Class A, B or C, may be applied over foam plastic when the foam is separated from the interior of the building by plywood sheathing not less than ½ in. in thickness with exterior glue, with edges supported by blocking, tongue and groove joints, or other approved type of edge support, or an equivalent material.

c. Foam plastic having a flame spread rating of 75 or less may be used as siding backer board with a maximum of ⅜ in. thickness when it is of not more than 2000 BTU per sq ft and is separated from the interior of the building by not less than 2 in. of mineral insulation or equivalent.

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Chapter 5—Materials

500 *General*

Materials installed shall be of such kind and quality to assure that the dwelling will provide (a) adequate structural strength, (b) adequate resistance to weather, moisture, corrosion and fire, (c) acceptable durability and economy of maintenance, and market acceptance.

500–1 Referenced Standards

Except as modified herein, material shall comply with the applicable standards listed in Appendices C & F. The current edition of the nationally recognized standards referenced herein shall govern except where the reference is to a specified dated standard

500–2 Exceptions

Exceptions to the referenced standards are included in this MPS where deemed appropriate by HUD.

500–3 Suitability of Alternate or Special Materials

Alternate or special materials or products, other than those contained herein, may be used when found acceptable by established HUD procedures and 513.

501 *General Requirements—Labeling*

Materials and products with mandatory labeling requirements shall be labeled or otherwise identified as conforming with the applicable standards. Mandatory labeling requirements, where applicable, are contained herein for specific materials and products.

502 *Site—Soil Treatment*

When the soil treatment method of termite protection is permitted by Federal, state and local regulations and is used, the chemicals and concentrations shown in Table 5–2.1 shall be applied in accordance with 602–3.

TABLE 5-2.1 - SOIL TREATMENT CHEMICALS

Chemicals	Concentrations
Aldrin	0.5% Applied in water emulsion
Chlordane	1.0% Applied in water emulsion
Dieldrin	0.5% Applied in water emulsion
Heptachlor	0.5% Applied in water emulsion
Chlordane and Heptachlor	0.5% Chlordane plus 0.25% Heptachlor a 0.75% solution applied in water emulsion

503 *Concrete*

503-1 Sulfate Resistance

In areas where moderate sulfate resistance is required (150 to 1000 ppm in water samples or 0.10 to 0.20 percent in soil samples) use Type II or IIA cement. Where high sulfate resistance is required (more than 1000 ppm or 0.2 percent respectively) use Type V cement. Other types of portland cement may be used provided the cement does not contain more than 8 percent $Ca_3Al_2O_6$ (tricalcium aluminate) where moderate sulfate resistance is required nor 5 percent $Ca_3Al_2O_6$ where high sulfate resistance is required.

503-2 Calcium Chloride

Calcium chloride may be added to concrete in amounts no greater than 2 percent (by weight of cement) to accelerate setting and hardening of concrete except that the chloride content of concrete in which galvanized shapes are embedded shall not be detrimental or deleterious to the concrete or metal. Calcium chloride or admixtures containing calcium chloride shall not be used in concrete in which aluminum, prestressing tendons or galvanized reinforcement are embedded.

503-3 Mixing Water

Water shall be clean, and free of substances deleterious to concrete or other embedded items.

503-4 Admixtures

Admixtures, when used, shall be added at the mixing or batching plant only. See Appendix C.

503-5 Lightweight Aggregate

503-5.1 *Durability*

In the absence of a proven record of the satisfactory durability of lightweight aggregate in structural concrete, lightweight aggregate shall be required to pass an accelerated soundness test as specified in ASTM C 88. The loss of weight of lightweight, fine or coarse aggregate in 5 cycles of the accelerated soundness test shall not be greater than 8 percent if sodium sulfate is used or 10 percent if magnesium sulfate is used. Proof that concrete containing unproven aggregate has an adequate durability factor shall consist of satisfactory performance when tested in accordance with ASTM C 666.

503-5.2 *Shrinkage*

Drying shrinkage of lightweight aggregate concrete consisting of aggregate of unknown shrinkage characteristics shall be tested in accordance with ASTM Method C 157.

504 *Masonry—Mortar Types and Uses*

Mortar type and usage shall comply with Table 5-4.1.

TABLE 5-4.1 - MORTAR USES

Kind of Masonry	Type of Mortar Required (6)
Foundation walls or piers	M or S (1)
Exterior walls above grade	S or N (2)(3)
Exterior cavity walls	M or S
Reinforced masonry	M or S (4)
Grouted or filled Cell Masonry	M or S (4)
Chimneys	S or N
Interior bearing walls	S or N
Interior non-bearing walls	S, N or O
Retaining Walls	M
Sewers and manholes	M
Ceramic veneer	S or N (5)
Glass block	N
Gypsum block	Gypsum mortar
Fire brick	Refractory mortar

Notes:

(1) Type N may be used with solid units when parged.

(2) Type S may be required in high wind areas.

(3) Type O may be used for exterior walls where facing and backing is solid units.

(4) Type M or S as required by design strength.

(5) Aggregate shall not exceed 4 times the Portland cement content.

(6) Mortar shall comply with ASTM C 270 requirements for unreinforced masonry and ASTM C 476 for reinforced masonry.

505 *Metals*

505-1 Steel

505-1.1 *Structural Steel*

Structural steel used in building construction shall conform to the ASTM standard appropriate to its grade and use.

505-1.2 *Concrete Reinforcement*

Reinforcing steel shall be in accordance with the recommendations of the American Concrete Institute.

505-2 Aluminum

Aluminum shall be in accordance with the Specifications for Aluminum Structures of the Aluminum Association.

505-2.1 *Wrought Alloys*

Wrought aluminum alloys shall fall within the following composition limits:

Silicon	7.0% max.
Magnesium, Manganese, Chromium	6.0% total max.
Iron	1.0% max.
Copper	0.4% max.
Zinc	1.0% max.
Others	0.5% total max.
Aluminum	Balance

These limits apply to both bare products and the core of clad products. The cladding of clad products shall be within the same limits except that the maximum zinc limit may be 2.5 percent in order to assure that the cladding is anodic to the core.

Special wrought alloys with a silicon content up to 7.0 percent may be acceptable for structural uses where special appearance is desired.

505-2.2 *Cast Aluminum Alloys*

Cast aluminum alloys shall be those in which the alloying elements are silicon, magnesium, manganese or a combination of these. Other elements shall not exceed the following limits:

Iron	1.2% max.
Copper	0.4% max.
Nickel	0.4% max.
Titanium	0.2% max.
Others	0.5% total max.

505-3 Light Gauge Sheet Metal Work

Light gauge sheet metal for non-structural work shall be in accordance with 507.

505-4 Metal Curtain Walls

Metal curtain walls shall comply with NAAMM Specifications (See Appendix C). Each metal curtain wall panel shall bear the manufacturer's label and certification of compliance with applicable standards.

505–5 Corrosion-Resistant Metals

The following metals are considered to be corrosion-resistant:

Sheet metal, nails or hardware of aluminum alloys, brass, bronze, copper, galvanized steel, lead, stainless steel, terne plate, or zinc-copper alloys.

506 *Carpentry*

506–1 Materials

506–1.1 Material shall comply with specific grading requirements of the association recognized as covering the material or species used, and under whose grading rules it is produced.

506–1.2 Structurally end-jointed lumber, may be used interchangeably with solid sawn lumber of the same grade and species.

506–1.3 Edge-glued and finger jointed end-glued kiln dried lumber may be used for non-structural purposes, interior and exterior. When considered necessary by the HUD field office, test data may be required.

506–1.4 Finish Materials are covered in 509.

506–2 Grademarking and Labeling

506–2.1 *Lumber*

All load bearing lumber shall conform to applicable standards or grading rules and shall be so identified by a grade mark, or Certificate of Inspection issued by a recognized lumber grading or inspection bureau or agency. The grade mark on such load bearing lumber shall provide adequate information to determine Fb, the allowable stress in bending and E, the modulus of elasticity.

506–2.2 *Plywood*

Each sheet of plywood used structurally or as underlayment shall bear the mark of a recognized association or independent agency. See Appendix F.

506–2.3 *Fire Retardant Lumber*

Each piece of fire retardant pressure treated lumber and plywood shall be labeled with a permanent mark which indicates a classification of pressure treated wood that does not have a flame spread rating higher than 25, with no evidence of significant progressive combustion when tested for 30 minute duration. See Appendix C.

506–2.4 *Decay Protection*

Lumber required to be protected against decay shall be protected by one of the following methods:

a. Pressure treated wood, treated and labeled in accordance with the applicable AWPB standard.

b. Vacuum and non-pressure treated exterior millwork shall be labeled to conform to NWMA–IS–4. Material bearing the MWMA Seal of Approval shall be accepted as conforming to the applicable standard.

c. Naturally resistant species of grades shown in Table 5–6–1.

Notes:

(1) Material shall be grademarked in accordance with 506–2.1.

(2) These grades define material of all heartwood or with very limited sapwood.

506–3 Moisture Content of Framing Lumber

Moisture content of dimension lumber and board lumber shall not exceed 19 percent at time of installation. Moisture content of dimension lumber and board lumber shall not exceed 15 percent at time of installation in areas where the average annual precipitation is 15 in. or less.

506–4 Conditions of Use

506–4.1 *Lumber*

Lumber shall be of a grade suitable for the intended use and in compliance with the following:

a. Timbers and dimension lumber used as structural members shall be of a species and grade which will provide sufficient strength and rigidity to support the design load without exceeding allowable stresses and deflections. All species of softwood stress-grade lumber may be used for floor, ceiling and roof framing subject to the maximum allowable span for the particular species, grade, use and spacing.

b. For board lumber, in general, knots or knot holes shall not exceed ⅓ of the width of the piece and splits shall not exceed ⅓ of the length of the piece. Boards with defects greater than these may be used if defects are sawn out.

c. Structural glued laminated timber shall comply with the AITC Timber Construction Manual or PS–56.

506–4.2 *Hardboard*

a. Hardboard shall be of the following types for the locations indicated:

(1) Exterior wall finish and other surfaces exposed to weather, Siding grade.

(2) Interior wall finish, baths or kitchens, Class I—Decorative grade.

(3) Other interior wall finish, Class I or II—Decorative grade.

(4) Floor underlayment, Underlayment grade.

b. Special hardboard products shall be evaluated in accordance with 513.

506–4.3 *Particleboard*

Particleboard floor underlayment shall comply with ANSI A208.1 Grade 1–M–1 and, in addition, shall exhibit a max. thickness swelling of 0.063 in. when immersed in water for 24 hrs in accordance with ASTM C 1037.

506–4.4 *Sheathing Paper*

Asphalt-saturated building paper shall be free from holes and breaks, weigh not less than 14 lbs per 100 sq ft and shall have a permeance of not less than 5 perms.

506–4.5 *Plywood*

Plywood shall be of the type shown for specific location in Table 5–6.2.

TABLE 5–6.1 – DECAY RESISTANT SPECIES (1)

Species	Grades (2)		
	Finish	Siding	Dimension
California Redwood	Clear All Heart, Select Heart or Construction Heart	Clear All Heart	Foundation Grade, No. 2 Foundation Grade, Select Heart, or Construction Heart
Tidewater Red Cypress	Clear Heart Finish or A Finish	A Siding	Heart Common
Western Red Cedar	Clear Heart	Clear V.G. Heart	Foundation

TABLE 5-6.2 - PLYWOOD

Location	Exposed to Weather	Not Exposed to Weather
Ext wall finish	Ext	---
Int wall finish	---	Interior (2)
Int ceiling finish	---	Interior
Wall sheathing	(1)	Interior Const. or Ext
Roof sheathing	(1)	Interior Const. or Ext(6)
Subflooring	(1)	Interior Const. or Ext
Underlayment	---	Interior Const. (2)
Combin. subfloor-underlayment	(1)	Interior Const.
Truss gussets	Ext (3)	Ext (4)
Built-up structural members	Ext (3)	Ext (4)
Soffits	Ext (5)	---
Porch or carport ceiling	Ext (5)	---

Notes:

(1) Plywood having edge or surface exposed to the weather including underside of roof overhangs, soffits and ceiling of porches and carports shall be exterior type. This does not apply to surfaces in ventilated attics or ventilated basementless spaces.

(2) Plywood underlayment and wall finish in bathrooms shall have exterior glues.

(3) These shall be protected by roof covering or metal capping.

(4) Interior type may be used if bonded with exterior glues.

(5) May be sanded panels with surfaces painted according to 609-7.2a.

(6) If subject to prolonged exposure during construction, use interior type with exterior glue.

507 *Thermal and Moisture Protection*

507-1 Waterproofing and Dampproofing

507-1.1 *Waterproofing*

Materials used for waterproofing shall be of proven effectiveness and durability to prevent the passage of water when subjected to the design hydrostatic pressure.

507-1.2 *Dampproofing*

Materials used for dampproofing shall be of proven effective and durability to retard the passage of water when subjected to the design moisture conditions.

507-1.3 *Foundation Drainage*

The min. water inlet area of perforated corrugated plastic drainage tubing shall be 1.25 sq in. per lineal ft of tubing.

507-2 Vapor Protection

Materials used for vapor retarders shall be of proven effectiveness and durability and of the required vapor permeance. Vapor retarders shall provide at least the resistance to moisture penetration required by this standard when tested in accordance with ASTM E 154 for durability and ASTM E 96 for permeability. See 402-3, 402-4, 603-4 and 607-2.

507-2.1 *Basementless (Crawl) Spaces and Concrete Slabs-On-Ground*

Materials used for vapor retarders over ground in basementless (crawl) spaces and concrete slabs-on-ground shall comply with the following when tested in accordance with ASTM E 154:

a. Wet Tensile Strength. Reduction in the average wet tensile strength shall not be more than 15% of the specimen's original recorded strength. Min. wet tensile strength shall be 10 lb. per in. of width in the weaker direction.

b. Resistance to Puncture. Max. load shall not be less than 25 lb.

507-2.2 *Other Areas Requiring Vapor Barriers*

Max. vapor permeance in other areas requiring vapor retarders shall be as required by this standard. Retarder shall be tested for permeance in accordance with ASTM E 96 and C 355.

507-3 Building Insulation

507-3.1 Materials used for insulation shall be of proven effectiveness and adequate durability to assure that required design conditions concerning heat losses, sound control or fire rating are attained. Insulation in contact with the ground shall not be adversely affected by soil, vermin or water.

507-3.2 *Labeling*

Labeling of insulation shall be as follows:

a. Batt or Blanket. Type, manufacturer or distributor, R value of the fiber at the labeled thickness.

b. Reflective. Type, manufacturer, R value for direction of heat flow, type of facing.

c. Blowing or Pouring Type. Name, manufacturer, recommended installation density, R value marking on bag of conformance with appropriate standards listed in Appendix C.

d. Labeling and marking of all other insulation materials shall comply with the appropriate standard listed in Appendix C.

507-3.3 *Certification*

A certification card giving the data of 507-3.2 a, b, c or d and 507-3.4d plus date of installation, and the name of the installer shall be affixed to the structure in an accessible but inconspicuous location.

507-3.4 *Conditions of Use*

a. Foam plastic insulation surfaces shall have a flame spread rating of 0-75 tested in accordance with ASTM E 84. In all habitable rooms and in nonhabitable areas such as utility rooms, garages and basements using foam plastic for insulation, the insulation shall be installed within the cavity or on the exterior of a masonry wall or shall be separated from the building interior by a material having a finish rating of at least 15 min. such as ½ in. gypsum wall board.

b. When installing insulation in attics and eave vents are provided, a one in. clearance under the roof deck must be allowed to permit the upward flow of the incoming air above the surface of the insulation. To insure that the clearance is provided when blown or poured type insulation is used, baffles of durable material shall be installed prior to the installation of insulation.

c. Vermiculite and perlite used as a fill insulation in masonry walls shall be of the water repellent type.

d. Loose fill cellulosic insulation pneumatically installed in wall cavities shall (1) be blown-in dry in accordance with the manufacturer's written instructions and shall comply with FS HH-I-515D and (2) the R value shall be based on an installed density (ID) of not less than 3.5 lb/cf. ID is the ratio of the weight of the installed material (w) divided by the volume (v) of the wall cavity and shall equal or exceed 3.5 lb/cf.

507-4 Shingles and roofing

For moisture protection requirements concerning roof underlayment, wall sheathing paper and exterior finish requirements, see 509.

507-5 Sheet Metal

507-5.1 *Zinc Coating*

Zinc coating for galv steel or iron shall not be less than G90, 1.25 oz, per sq ft (total weight both sides).

507-5.2 *Terne Plate*

The min. weight of coating for terne plate (lead-tin alloy coated steel) shall be 1.45 oz per sq ft (40 lb grade, per double base box).

507-5.3 See Table 5-7.1 for Uses of Sheet Metal.

507-6 Caulking and Joint Sealants

Materials used for caulking and sealants shall be suitable for the use intended, shall be compatible with the materials to which they are applied and to any finish which may be applied over them.

507-6.1 *Labeling*

a. Each container of caulking and sealant shall be labeled with the name, type, manufacturer's name or symbol and compliance with the applicable standard.

b. Special construction materials shall be submitted for evaluation in accordance with 513.

507-6.2 *Conditions of Use*

a. Use non-skinning compounds (butyl polymers) in unexposed locations.

b. Use polyvinyl chloride (vinyl) in areas not subject to ambient temperatures in excess of 150 F.

c. Use preformed sealing tapes in lcoations of compressive confinement and on non-porous surfaces.

d. Use preformed sealing tapes of the uncured types in unexposed locations.

e. Use compression seal gaskets in locations of compressive confinement.

507-7 Gutters and Downpouts

507-7.1 *Gutters*

a. Sheet metal shall comply with 507-5.

b. Wood gutters shall be of a natural resistant species or equivalent.

507-7.2 *Downspouts*

a. Sheet metal for ext. downspouts shall comply with 507-5.

b. Int. downspouts shall be cast iron, steel or copper pipe, ABS or PVC plastic pipe. See Appendix F.

507-8 Special Flashing Materials

Special flashing materials such as bituminous fabrics, plastics, combination flashings, etc., are considered non-standard materials. See 513.

TABLE 5-7.1 — SHEET METAL USES

	MATERIALS								
	Aluminum (1)(2)(8)(9)		Copper (7)(8)	Galv. Iron or Steel (7)(8)		Lead (7)(8)	Stainless Steel (7)(8)	Terne Plate (7)(8)	Zinc-Copper Alloy (7)(8)
	Minimum			Minimum Gage					
Use	Thickness in. (1)	Tensile Strength psi	Minimum Thickness in.	(16 oz.) (1.25 oz.)	(1.50 oz.)	Minimum Weight psf	Minimum Thickness in.	Min. Gage ga.	Minimum Thickness in.(2)
Aprons	—	—		16	16	—	—	—	—
Flashing									
exposed	.019	[illegible]	.020	26	24	2.5	.015	30	.020
concealed	.015	16,000	.012	28	30	1.5	.010	30	.012
Hood	.024	16,000	.020	28	28	—	.015	30	.020
Gutters	.027	16,000	.020(6)	26	26	—	.015	—	.025
Downspouts	.020	16,000	.020(6)	26	24	—	.015	—	.025
Roofing	.024(3)	19,000	.020	26	26	3.0	.015	—	.020(2)
Siding	(4)	—	—	24	24	—	—	—	—
Roof Valley	.019	16,000	.020	26	26	2.5	.015	30	.020
Gravel Stop (Fascias)	.024	19,000	.020	24	24	—	.015	—	.020
Ventilators	.027	16,000	—	24	26	—	—	—	—
Ductwork	(5)	16,000	—	(5)	(5)	—	—	—	—
Shower Pans	—	—	.015	—	—	4.0	—	—	—

Notes:

(1) Thickness shown is nominal thickness. Actual min. thickness may be 0.002 in. less to allow for rolling tolerance.

(2) Zinc-copper alloy gutters, downspouts, roofing, or other fabricated products where additional stiffness is required shall be of semicold rolled temper and shall contain not less than 0.80 percent copper.

(3) Roof shingle thickness 0.019 in. min.

(4) Siding materials shall comply with AAMA – 1402.3.

(5) Comply with NFPA–90–B.

(6) Use cold-rolled temper copper.

(7) The following metals shall not be used in contact with the materials shown unless suitable protected:

a. Aluminum alloys, galvanized steel or galvanized iron in contact with metals other than zinc.

b. Aluminum alloys in contact with wood containing wood preservatives other than pentachlorophenol, Wolman salts, creosote or zinc naphthanate.

c. Alumimum alloys in contact with concrete, masonry or absorbent materials likely to be continuously or repeatly wet.

d. Copper in contact with metals other than lead.

e. Stainless steel or terne plate in contact with other metals.

f. Zinc-copper alloys in contact with copper or high copper alloys.

(8) Nails and fittings used with various metals shall be of the same material except as follows:

a. Hot-dipped galvanized gutter spikes may be used with aluminum alloy gutters.

b. Hot-dipped galvanized or aluminum nails and fittings may be used with zinc-copper alloys.

(9) Aluminum conduit, piping or ductwork shall not be imbedded in concrete slabs, columns, beams or walls.

508 *Doors, Windows, Glazing Panels*

508–1 Performance Testing

All windows and sliding glass doors shall be tested for air infiltration, water penetration and physical loading as set forth in Appendix D. The test unit shall be the largest size marketed by the manufacturer or the size designated in the referenced specification. All windows and sliding glass doors shall equal or exceed the minimum performance levels.

Glass requirements set forth in these standards take precedent over glass requirement in any referenced standard.

508–2 Metal Doors and Frames

508–2.1 *Steel Doors*

a. Each interior and exterior steel door shall be labeled identifying the manufacturer certifying compliance with the applicable standard.

b. Exterior steel doors designed and constructed to withstand moisture and temperature conditions below 0° F where the average annual precipitation is 20 in. or more shall be so labeled.

c. Steel sliding glass door units shall bear a label identifying the manufacturer, certification of compliance with the tests required in 508–1, name of the certifying organization, and the max. size of the unit tested.

508–2.2 *Aluminum Doors*

Each aluminum sliding glass door and aluminum storm door shall bear the label of an indpendent inspection agency. The label shall identify the manufacturer by name or symbol, and shall certify compliance with the applicable standard.

508–3 Wood Doors

508–3.1 *Materials*

a. Doors may be complete manufactured units or stock doors and frames. Job-built wood frames may be used. Job assembled doors and frames shall meet the requirements of Sections 3.6, 3.6.1, and 3.6.2 of PS 32–70.

b. Entrance doors shall be of exterior type as defined in the applicable referenced standard and not less than 1¾ in. thick. Service doors (where temperature is near the same on both sides) may be 1⅜ in. thick. Exterior door frames shall be decay treated in accordance with 506–2.4 and 606–3.

c. Interior hinged doors shall be not less than 1⅜ in. thick. Closet doors may be 1⅛ in. thick provided that warp does not exceed ¼ in.

508–3.2 *Labeling*

a. Each door shall bear a label or otherwise be suitably identified as to the name of manufacturer and compliance with applicable standard.

b. Each exterior flush veneered door shall bear the label of independent inspection agency indicating compliance with requirements for a Type 1 door under the applicable standard. See Appendix F for accepted independent inspection agencies.

c. Each wood sliding glass door unit shall bear a label identifying the manufacturer, certification or compliance with the applicable standard, the name of the certifying organization and the max. size of the unit tested.

508–4 Special Doors—Garage Doors

Design and construction of garage doors shall be acceptable to the HUD field office and shall be labeled to identify the name and address of the manufacturer.

508–5 Metal Windows

508–5.1 *General*

When metal windows or sliding glass doors are proposed in areas subject to a winter design temperature of 10° F or lower, insulating frames shall be provided. Criteria shall be as set forth in AAMA 1502.6, Voluntary Standards and Tests of Thermal Performance of Residential Insulating Windows and Sliding Glass Doors. Where wood is used as the insulator, it shall be water repellent preservative treated.

508–5.2 *Steel Windows*

Steel windows shall bear a label identifying the manfacturer, certification of compliance with the tests required in 508–1, name of the certifying organization and the max. size of the unit tested.

508–5.3 *Aluminum Windows*

Aluminum windows shall bear the label of an independent inspection agency. The label shall identify the manfacturer by name or symbol, and shall certify compliance with the applicable standard.

508–6 Wood Windows

508–6.1 *Operating Wood Windows*

Operating windows shall be manufactured units including frame, sill, sash, weatherstripping and operating hardware. Job site assembled windows composed of frames and sash made by different manufacturers are not acceptable.

Each operating wood window unit shall bear the label of an independent inspection agency. The label shall identify the manufacturer by name or symbol and shall certify compliance with the applicable standard. See Appendix F for accepted independent inspection agencies.

508–6.2 *Fixed Sash Windows*

Fixed sash windows (picture windows, bay windows) may be manufactured units of job-built or job assembled units of stock or special sash and frames.

508–6.3 *Decay Treatment Requirements*

For decay treatment requirements, see 506-2.4 and 606-3.

508-7 Hardware

508-7.1 Hardware shall comply with 401-2.3. Locks shall meet or exceed the performance criteria of ANSI A156.2 for the series and grades as follows:

a. Living unit entrance doors and building entrance doors serving one or two families, series 4000, grade 2.

b. Doors within living units, series 4000, grade 3.

The performance criteria are considered to be Sections 8, 9 and 10 of ANSI A156.2. Evidence of conformance shall be provided to the HUD field office when requested.

Use three butts on all exterior doors.

508-7.2 *Labeling*

Locks shall be labeled as complying to the performance criteria of the applicable series and grade of ANSI A156.2. This information shall appear on the lock or in the installation instructions or on the packing box.

508-7.3 *Screening*

a. Insect screening for windows shall be 18 x 14 mesh or equivalent.

b. Hardware cloth for ventilators shall be 8 x 8 mesh.

c. Structural spaces may be ventilated by prefabricated panels having slots not exceeding ⅛ in. x 1 in.

508-8 Glazing Panels.

508-8.1 *Safety Glazing.*

a. Safety glazing materials shall be used in the locations specified by and shall be in compliance with the Consumer Product Safety Commission's (CPSC) Safety Standard for Architectural Glazing Materials. Table 5-8.1 shows the location and product category required by CPSC.

TABLE 5-8.1 - TABLE OF SAFETY GLAZING REQUIREMENTS

Glazing Location	Size of Individual Panes	Product Category (2)
Doors, Storm doors, Combination doors, Glazed panels (1)	Not greater than 9 sq ft	I
	Greater than 9 sq ft	II
Shower and bathtub doors and enclosures	All sizes	II
Sliding glass doors (patio type)	All sizes	II

Notes:

(1) Glazed panels are any piece of operable or nonoperable glazing material adjacent to a door whose nearest vertical edge is within 12 in. from the door in a closed position and whose bottom edge is below the level of the top of the door.

(2) The product category is identified on the label and is determined by test in accordance with the CPSC Standard. Category II products are stronger than Category I products.

b. The following products, materials and uses are exempt from the CPSC requirements:

(1) Wired glass used in doors or other assemblies to retard the passage of fire, where such door or assembly is required by a Federal, state, local or muniucipal fire ordinance.

(2) Louvers of jalousie doors.

(3) Openings in doors through which a 3 in. diameter sphere is unable to pass.

(4) Leaded glass panels where no individual piece of glass has an area greater than 30 sq in.,

(5) Glazing materials used as curved glazed panels in revolving doors.

508-8.2 *Quality.*

a. Glass quality shall be as required by HUD for the particular use proposed. Sheet glass shall not be less than q6 or "B" quality.

b. Glass for all mirrors shall be of mirror or silvering quality.

c. Insulating glass shall be hermetically-sealed units with stated performance life guaranteed by the manufacturer.

508-8.3 *Maximum Glass Area.*

Max. areas of individual panes of glass used in doors, windows and panels shall be determined in accordance with wind load chart Fig. 5-8.1 (also see Fig. 6-1.1 and 601-6) and further adjusted in thickness for the particular use described as follows:

a. Min. thickness for windows, including storm windows, single strength, 0.085 in. See Fig. 5-8.1.

b. Glass thickness for doors when ordinary (annealed) glass is used above 3 ft 6 in. See 508-8.1.

(1) Min. thickness of the individual glass pane shall be single strength 0.085 in.

(2) When the least dimension of pane exceeds 15 in. double strength 0.115 in. min. shall be used

(3) When area of pane exceeds 6 sq ft, 3/16 in. (0.182 in.) min. thickness shall be used.

c. Glass installed in jalousies shall be at least 7/32 in. in thickness and not longer than 36 in. Exposed edges shall be seamed, ground or polished to prevent injury.

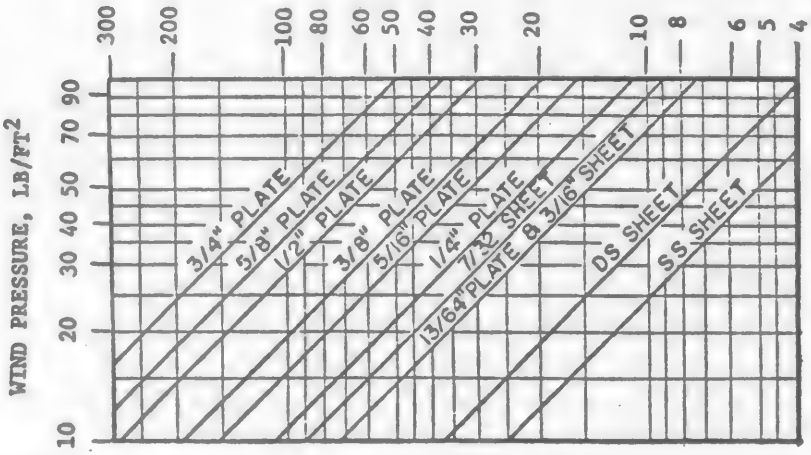
508-8.4 Labeling.

a. Each pane of ordinary (annealed) glass installed in doors and windows shall bear a label showing the name of manufacturer, quality and type of glass.

b. Each pane of insulating glass units shall be labeled in accordance with a.

c. Each pane of safety glazing material shall be permanently labeled. The label shall be visible after glazing and show the name of the manufacturer, nominal thickness and compliance with referenced safety standard.

WIND LOAD CHART - Fig. 5-8.1 - MAXIMUM GLASS AREA, SQ FT



Notes:

Required nominal thickness of regular float-plate or sheet glass based on min. thickness allowed in FS DD–G–451c. Refer to ANSI A58.1, Parts and Portions, for wind pressure and Fig. 6–1.1 for wind velocities.

(1) Chart applies when short dimension divided by long dimension equals more than ⅓.

(2) Chart assumes glass supported on all four edges, deflection of glass supports limited to 1/175 of span for design load with laps and edge clearances perfomance engineered.

(3) Max. window glass areas from Fig. 5–8.1 shall be adjusted for relative resistance to wind loads for glass types as follows:

Glass Type:

Heat strengthened..... 2 times area shown.
Fully tempered.....4 times area shown.
Laminated..... 60 percent of area shown.
Wire glass..... 50 percent of area shown.
Sand blasted annealed glass...40 percent of area shown.
Sealed insulating units for the thinner light in the assembly...1½ times area shown.

509 *Finish Materials.*

509–1 General.

509–1.1 Finishing materials shall be commensurate with the type of housing proposed, with provisions for fire safety, durability and ease of maintenance; and for exterior applications shall restrict the entrance of air and moisture and shall be resistant to deterioration by the elements.

509–1.2 Conformity with the applicable standards in 509 of Appendix C except as modified herein, shall constitute compliance with these standards.

509–2 Exterior Wall Finishes.

509–2.1 *Materials.*

a. Wood siding and handsplit shakes, shall comply with the specific grading requirements of the association recognized in the trade as covering the particular species.

b. Shingles, machine grooved shakes, and handsplit shakes shall be red cedar, cypress, or redwood. Handsplit shakes shall be 100 percent heartwood with clear exposed face. Tapersplit and straight-split shakes shall be 100 percent edge grain, and resawn shakes shall be 90 percent edge grain. Wood shakes may have ⅛ in. sapwood on one edge.

c. Metal Siding—See Table 5–7.1.

d. Textured Plywood Panel Siding—See Table 5–6.2 and Appendix F.

e. Materials used for soffits, porch and carport ceilings shall meet the requirements for exterior wall finishes.

509–2.2 *Labeling.*

a. Each bundle of shingles of shakes shall be labeled with the grade, species, and compliance with the applicable commercial standard.

b. Each panel or package of hardboard shall be labeled with the manufacturer's name, compliance with the applicable standard and with the specific type of hardboard.

c. Special hardboard products described in the AHA industry standard appendix maybe used if produced from basic hardboard complying with 509–1.1. Other hardboards are considered special products and shall be submitted for consideration in accordance with paragraph 500–3.

509–2.3 *Conditions of Use.*

a. Grade of wood siding and handsplit shakes shall be suitable for the intended use. Wood siding shall be kiln-dried or otherwise seasoned to the approximate moisture which will be attained in service.

b. Shingles shall be No. 1 or No. 2 for face course and when double-coursed may be No. 2, No. 3, or Undercoursing Grade for undercourse. Machine groove shakes shall be No. 1.

c. Use siding grade hardboard for exterior wall finish and other surfaces exposed to weather.

509–3 Roof Coverings.

509–3.1 Materials.

a. Machine groove wood shingles and shakes having butt thickness less than ½ in. shall not be used for roofing applications.

b. Wood shingles and shakes shall comply with the specific grading requirements of the association recognized in the trade as covering the particular species.

c. Wood shingles and shakes shall be red cedar, cypress, or redwood. Shakes shall be 100 percent heartwood with clear exposed face, except that ⅛ in. of sapwood shall be permitted on one edge. Tapersplit and straight-split shakes shall be 100 percent edge grain and resawn shakes shall be 90 percent edge grain.

509–3.2 *Labeling.*

a. Each bundle of shingles or shakes shall be labeled with the grade, species, and statement of compliance with the applicable standard.

b. Rolls or containers of bituminous products shall be labeled as being in compliance with the applicable standard.

509–3.3 *Conditions of Use.*

Wood shingles shall be No. 1 or No. 2.

509–4 Interior Wall and Ceiling Finishes.

509–4.1 *Materials.*

See Table 5–6.2 for plywood.

509–4.2 *Labeling.*

Hardwood plywood shall be labeled to show the grade, species and stain or simulated decorative finish of the face ply and compliance with the applicable standards.

509–4.3 *Conditions of Use.*

a. Wall finishing materials shall provide a washable finish to the extent of removing ordinary household stains. The finish of walls in kitchens, bathrooms and laundries shall be resistant to damage from grease, water, detergents and normal household chemicals.

b. Wainscot in showers or tub enclosures with shower shall be materials recommended by manufacturer for this use.

c. Gypsum wallboard used as backing for wainscot in showers or tub enclosures shall be water resistant. Insulating (foil-backed) wall board shall not be used in this area.

d. When hardboard is used, use Class I-Decorative grade hardboard for interior wall finish of baths, kitchens or laundries and Class I or II-Decorative grades hardboard for other interior wall finishes.

509–4.4 Elderly Housing.

Abrasive wall finish such as a sand finish shall not be used in housing for the elderly.

509–5 Finish Flooring, Rigid.

509–5.1 *Materials.*

a. Wood flooring shall comply with the grading requirements of the association recognized as covering the mate under whose grading rules it is produced.

b. Underlayment and adhesives when used shall be as recommended by the manufacturer of the finish flooring.

509–5.2 *Labeling.*

a. Each bundle or package of wood flooring shall be labeled with grade and species.

b. Ceramic tile shall be identified as required by the applicable referenced standard.

509–5.3 *Conditions of Use.*

a. Wood flooring shall be kiln-dried or otherwise seasoned to moisture content approximately that which it will attain in service.

b. Floors in kitchens, laundries, and bathrooms and shall be resistant to damage from grease, water, detergents, and household chemicals.

c. Floors in housing for the elderly shall be slip-resistant.

509–6 Finish Flooring, Resilient.

509–6.1 *Materials.*

a. Adhesives and underlayments shall be designed for the specific installations and as recommended by the manufacturer of the finish flooring.

b. Particleboard floor underlayment shall comply with Appendix C and, in addition, shall exhibit a maximum thickness swelling of 0.063 in. when immersed in water for 24 hr in accordance with ASTM D 1037.

c. The thickness of resilient flooring may be less than required by the referenced standards in Appendix C, but not less than shown in Table 5–9.1.

TABLE 5–9.1 – MINIMUM RESILIENT FLOORING THICKNESSES

Material		Nominal Wearlayer Thickness (In.)	(2) Traffic Condition Where Material and Thickness are Acceptable			
			SMOOTH TILE		EMBOSSED TILE	
			Through Pattern	Surface Pattern	Through Pattern	Surface Pattern
Resilient Tile	Asphalt Tile	1/8	H	L	M	L
		3/32	M	L	L	L
	Rubber Tile	1/8	H	L	M	L
		5/64	M	L	L	L
	Vinyl Tile	.08	H	L	M	L
		.05	M	L	L	L
	Vinyl Asbestos Tile	1/8	H	M	M	L
		3/32	H	L	L	L
		1/16	M	L	L	L
Resilient Sheet (1)	Rotovinyl (3)	0.020	H			
		0.014	M			
		0.010	L			
	Vinyl Plastic (Backed) Sheet	0.050	H			
		0.030	M			
		0.020	L			
	Linoleum	0.090	H			
		0.050	M			

Notes:

(1) Wearlayer may be smooth, embossed or otherwise textured.

(2) H (heavy traffic)—public stairs, entrance corridors, lobbies, elevators. M (medium traffic)—stairs within living units and public areas except those designated under H above. L (light traffic)—areas within living units except stairs.

(3) Floor covering with translucent or transparent vinyl surface with backing.

509–6.2 *Conditions of Use.*

a. Hardboard used as floor underlayment shall be underlayment grade.

b. Floors in kitchens, laundries, and bathrooms shall be resistant to damage from grease, water, detergents, and household chemicals.

c. Floors in housing for the elderly shall be slip-resistant.

509–7 Painting.

509–7.1 *History of Use.*

All paints, stains or other coatings shall have a history of satisfactory use under conditions equal to or similar to the conditions present in the area concerned.

509–7.2 *Record of Use.*

When considered necessary, experience records of sufficient duration to permit evaluation of the material's suitabillty may be required.

509–7.3 *Lead Content.*

No paint shall contain more than .06 percent lead by weight (or the amount permitted by the current HUD regulation) calculated as lead metal in the total non-volatile content of liquid paints or in the dried film of paint already applied.

509–7.4 *Suitability.*

The paint, stain or coating system selected shall be designed for and recommended by the manufacturer for the specific use proposed. The printed application instructions shall clearly identify the suitabilty of the material for the type of exposure (exterior or interior), the type of surface to be covered (wood, metal, masonry, concrete, plaster, etc.) and the conditions to which the paint will be subjected (exposure to moisture, frequent washing, relatively heavy traffic, etc.). If a paint proposed for exterior surfaces is not inherently mold resistant, a suitable fungicide shall be included in the formulation.

509–7.5 *Washability.*

Interior finish coat shall provide a washable finish to the extent of removing ordinary household stains. The finish of walls in kitchens, bathrooms and laundries shall be resistant to damage from grease, water, detergents and normal household chemicals.

509–8 Wall Coverings.

509–8.1 *General.*

Wall coverings shall be of such kind and quality for a given material to assure (a) intended life, (b) renewability and (c) wall finishes in kitchens, bathrooms and laundries resistance to damage from grease, water, detergents and normal household chemicals.

509–8.2 *Wallpaper.*

a. Wallpaper colors shall be sunfast and waterfast.

b. Wallpaper in kitchen and bathrooms shall be of the water resistant type.

509–9 Other Finishes.

509–9.1 Other finishes installed shall be of such kind and quality to assure adequate rigidity, fire safety, resistance to moisture in areas subject to moisture and reasonable durability and economy of maintenance.

509–9.2 Carpeting and cushioning standards are listed in Appendices C and F.

510 *Specialties.*

510–1 Factory Built Fireplaces and Fireplace Stoves.

Factory built fireplaces and fireplace stoves shall be listed and labeled by a nationally recognized testing laboratory as being in conformance with standards in Appendix C.

510–2 Factory Built Chimneys.

Materials shall be in accordance with the testing laboratory listing and approval. See 610–2.

511 *Equipment.*

511–1 Kitchen and Lavatory Cabinets.

Job and factory built kitchen and lavatory cabinet materials shall be suitable for the intended use in accordance with 611–1.

511–2 Kitchen Equipment.

Kitchen equipment materials shall be suitable for the intended use and in accordance with 611–2.

512 *Furnishings—Carpets and Mats.*

For carpets and mats, see Appendices C & F.

513 *Special Construction Materials.*

513–1 Definition.

Special or alternate construction materials and products are those which are new or are not covered by specific requirements in these standards or in the referenced standards in Appendices C, E and F.

513–2 Usage.

Use of special or alternate materials and products is permitted within the limitations prescribed in 101–1 and in HUD Handbook 4950.1, Technical Suitability of Products Program, Technical and Processing Procedures.

513–3 Requirements for Acceptance.

513–3.1 *Special or Alternate Materials.*

Acceptance of special or alternate materials and products on a continuing basis will be determined in conformance with the established HUD procedures described in HUD Handbook 4950.1.

513–3.2 *Materials Releases (MR).*

These technical suitability documents provide for the national acceptance of specific non-standard building materials and products not covered in the current MPS. They are also addenda to the MPS. Materials Releases are issued by the Headquarters for products deemed suitable for use in HUD housing programs.

513–3.3 *Use of Materials Bulletins (UM).*

A Use of Materials Bulletin is issued either as an interim HUD standard for a particular class of like products (e.g., carpet, PVC

piping), or as a means of promulgating a labeling or certification program (e.g., grade marking of lumber, certification program for aluminum windows). When used as an interim generic standard, a UM generally replaces several MR's which are withdrawn.

514 Reserved.

515 *Mechanical.*

515–1 Equipment and Labeling.

515–1.1 *Standards.*

All equipment, materials, accessories and appurtenances shall comply with the published and applicable standards, requirements, and recommendations of the nationally recognized authorities as listed in Appendices C, E & F.

515–1.2 *Labeling.*

All equipment, materials, accessories and appurtenances requiring labeling and listing by this Standard shall bear a permanent and legible factory applied nameplate to permit identification of manufacturer, model number and type of unit. Required testing and labeling shall be by agencies or testing laboratories satisfactory to HUD.

515–1.3 *Electrical Equipment.*

All electrical equipment, accessories and appurtenances shall comply with 516.

515–1.4 *Safety Devices.*

Operating, and limit or safety devices which are not tested as an integral part of an appliance shall be separately listed by a qualified testing, rating and listing agency.

515–2 Mechanical Ventilation.

515–2.1 *Duct Insulation.*

Supply and return air ducts, plenums, and enclosures used for heating, cooling or both which are installed in nonconditioned spaces, or for ventilation air ducts installed in conditioned spaces shall have all seams tightly sealed and shall be insulated with or have a minimum thermal resistance (R) value, excluding film coefficients of:

a. R=8.0 (hr×F×sq ft)/Btu for locations outdoors, attics, garages, ventilated crawl spaces and nonconditioned basements.

b. R=4.3 (hr×F×sq ft)/Btu for locations in insulated crawl spaces with tightly closing ventilators and sides of supply air ducts facing nonconditioned spaces (such as wall cavities).

c. External insulation on ducts used for cooling, shall be covered with a vapor retarder, maximum permeance of 0.05, and all joints shall be sealed against vapor penetration. When aluminum foil is used only as a vapor retarder, it shall have a minimum thickness of 2 mils. Insulation, including covering or coating, shall have a flame spread classification not to exceed 25 and a smoke developed rating not to exceed 50 when tested in conformance with ASTM E84, and shall carry a label indicating the fire hazard classification.

d. Insulation may be omitted on ducts in basements. It may also be omitted on ducts in crawl spaces having tightly closing ventilating louvers, a vapor retarder ground cover and perimenter walls insulated with the same insulation required for ducts in b above, or with blanket insulation providing equivalent insulating value.

e. Preformed air ducts used for heating, cooling and ventilating systems shall be labeled and installed in accordance with NFPA 90B. Regardless of the form of duct, the insulation value shall comply with a and b above. The duct shall be provided with a vapor retarder not exceeding a permeance of 3.0. Should the duct have an inner and exterior retarder, the inner barrier must have a permeance greater than the specified permeance of the exterior vapor retarder.

f. Acoustical duct liners shall conform to FS HH–I–545, Type I—flexible, flat. Minimum thickness shall be 1 in.

515–2.2 *Kitchen and Bathroom Fans.*

Kitchen and bathroom ventilating equipment shall comply with and be tested and rated in accordance with the Air Flow and Sound Test Procedures of the HVI, and related rating procedures. Evidence of compliance shall be a HVI, or manufacturer's label, showing model number, cfm, static pressure, and sound characteristics. Tests shall be made by a qualified independent laboratory.

514–2.3 *Sound Levels.*

Sound levels of kitchen exhaust and range hood fans shall not exceed 8.0 sones. Bathroom fans shall not exceed 6.5 sones.

515–2.4 *Externally Mounted Ventilators.*

Exterior mounted ventilators shall be of corrosion resistant materials and shall be listed, labeled and rated. The label shall state the cfm capacity in accordance with HVI testing and rating procedures for powered attic space ventilators and for living space ventilators wherever applicable.

515–2.5 *Safety.*

All ventilating equipment shall conform to the safety standards of HVI and shall be listed, labeled and rated, in addition to other safety requirements herein.

515–2.6 *Kitchen Exhaust Ducts.*

Ducts for kitchen exhaust shall be constructed of fireproof materials which are not adversely affected by range temperature, corrosion, or moisture.

515–3 Heating.

515–3.1 *Hot Water Piping.*

Piping used for conveying hot water for heating shall be manufactured of materials shown in Table 5–15.1.

515–3.2 *Heating Boilers.*

Hot water or steam heating boilers and their controls shall comply with applicable provisions of the ASME, ANSI, and NFPA and shall be tested and labeled by an independent inspection agency. Performance ratings shall conform to the published ratings and load recommendations of IBR, SBI, MCAA, and AGA.

515–3.3 *Baseboard Units.*

The heating output of convecting and baseboard radiation shall be determined in conformity with the appropriate product standard or the IBR Testing and Rating Code, and shall be approved by the appropriate rating committee.

515–3.4 *Burner Units.*

Oil and gas burner units shall be tested and listed by an independent inspection agency and shall be labeled in compliance with the appropriate product standard.

515–3.5 *Furnaces.*

Forced warm air furnaces shall be equipped with a temperature-actuated fan control or other suitable fan sequencing means complying with the accepted standard. Automatically fired warm air furnaces shall be equipped also with a temperature-actuated limit control.

515–3.6 *Room Heaters.*

Oil-fired and gas-fired heaters shall be labeled in accordance with the appropriate product standard.

515–3.7 *Storage Tanks.*

Fuel oil storage tanks shall be listed and labeled by an independent inspection agency.

515–4 Cooling

515–4.1 *Duct Insulation*

Duct insulation is covered in 515–2.1.

515–4.2 *Refrigeration System*

Refrigeration systems and components shall comply with the requirements of ANSI B9.1 or if gas fired, with ANSI Z21.40.1 or Z21.40.2, and shall be tested and rated in accordance with the applicable standards of ARI, and ANSI or AGA. Refrigerants used shall be approved as Group 1 refrigerants as classed in ANSI B9.1 except that a sealed absorption system may use Group 2 refrigerants when in compliance with ANSI B9.1.

515–4.3 *Unitary Air Conditioners*

Unitary air conditioners shall comply with requirements of ARI 210, and heat pumps with ARI 240. Both shall be tested and rated accordingly by an independent inspection agency or in a test facility approved by such a laboratory and witnessed by qualified personnel from the laboratory. Equipment shall be so labeled and test reports shall be available on request.

515–4.4 *Window Air Conditioners*

Window or through-the-wall air conditioners shall be listed and labeled in accordance with ANSI/UL484 and ANSI Z234.1.

515–4.5 *Sound Levels*

Outdoor sections of all unitary and heat pump equipment shall be sound rated and labeld in accordance with the appropriate ARI standard and installed to produce a sound pressure level based on a sound rating number not exceeding the value permitted by local ordinance, or in the absence of such ordinance, 60dBA maximum.

515–4.6 *Condenser Water Piping*

Piping used for conveying condenser cooling water shall be manufactured of materials shown in Table 5–15.1 and in 515–5 of Appendix C.

515–5 Plumbing

515–5.1 *Plumbing Materials and Equipment*

Except as modified herein, materials and equipment for plumbing and water supply shall comply with the standards referenced in Appendices C, F, and the nationally recognized model code.

State and local codes which deviate from nationally recognized plumbing codes or standards in order to satisfy local conditions may be accepted by HUD if such deviations are identified and substantiated with satisfactory engineering data.

515–5.2 *Piping*

Acceptable water and drainage piping materials and uses are shown in Table 5–15.1 and in 515–5 of Appendix C.

515–5.3 *Shower Drains*

Shower drains shall be of the double flange pattern type with weepholes and a flashing clamp device for attachment of the safe pan.

515–5.4 *Sump Pumps*

Sump pumps shall be tested, rated and labeled in conformance with the current SPMA Domestic Sump Pump Standards.

515–6 Domestic Water Heaters

515–6.1 *Direct-Fired Water Heaters*

Direct-fired oil or gas water heaters shall be listed and labeled by an independent inspection agency, and installed in accordance with the listing. Electric water heaters shall conform to UL174 (ANSI C33.87).

515–6.2 *Indirect Heaters*

Indirect water heaters shall be tested and rated in accordance with the IBR Code as published by the Hydronics Institute, and labeled to show compliance and rated capacity.

515–6.3 *Concealed Shutoff Devices*

Water heaters equipped with a concealed energy shutoff device shall be so labeled.

515–6.4 *Safety Devices*

All safety devices, except mixing valves, shall meet the current standards of one or more of the following orgnaizations: ANSI, AGA, ASME and NBBPVI. They shall be considered in compliance when listed and labeled by an indepenedent inspection agency.

515–6.5 *Test Pressure*

Direct-fired water heaters shall be constructed to withstand minimum 300 psi test pressure. Water connections shall be not less than 3/4 in. IPS.

515–6.6 *Warranty*

The warranty issued by the manfuacturer shall provide replacement parts found to be defective under normal conditions of service during the first year after installation. It shall further provide for the replacement of the entire heater assembly should a tank leak develop during the first 5-year period after initial occupancy of the living unit. The replacement heater shall be a current model of the same capacity as the one being replaced. The warrantee (owner) shall pay all delivery and installation costs for any replacement made under the warranty after the first year. The warranty shall remain effective regardless of change in the ownership provided the heater is not moved from the home. HUD assumes no responsibility for warranty endorsement.

515–7 Special Piping Systems—Gas Piping

Metalic gas piping used as distribution or service lines shall conform with NFPA 54 and 58. Plastic piping may be used when permitted by local codes.

515–8 Water Supply System

515–8.1 *Materials and Equipment*

Exept as modified herein, materials and equipment for water supply system shall comply with the applicable standards referenced in Appendices C, F, and the nationally recognized model code having jurisdiction in the area. State and local codes which deviate from nationally recognized plumbing codes or standards in order to satisfy local conditions may be accepted by HUD if such deviatipns are identified and substantiated with satisfactory engineering data. For water supply system piping, see Table 5–15.1.

TABLE 5-15.1

PIPING: WATER, DRAINAGE AND VENT

MATERIAL	USE						
	WATER PIPING (8)					DRAINAGE AND VENT PIPING	
	SERVICE	DISTRIBUTION		WATER PIPING FOR HEATING	CONDENSER WATER PIPING	BELOW GROUND	ABOVE GROUND
		UNDER SLAB	OTHER				
ASBESTOS-CEMENT	A(1)	--	--	NA	NA	A	A(1)
CAST IRON							
Water Pipe	A	A	A	A	A	--	--
Soil Pipe	--	--	--	--	--	A	A
No Hub Pipe & Fttgs.	NA	NA	NA	NA	NA	A	A
COPPER TUBING							
Type K-Hard Temper	A	A(7)	A	A	A	A	A
Soft Temper	A	A(2)	A	A	A	--	--
Type L-Hard Temper	A	A(7)	A	A	A	A	A
Soft Temper	A	A(2)	A	A	A	--	--
Type M-Hard Temper	A	NA	A	A	A	--	--
DWV Hard Temper	NA	NA	NA	NA	A	A	A
GALV. OPEN HEARTH OR WR. IRON	A(4)	A(4)	A	A	A	A(4)	A
GALV. STEEL PIPE	A(4)	A	A	A	A	--	A
BLACK STEEL PIPE	A(4)	NA	A	A	A	--	--
PLASTIC							
ABS(3)	A(5)	NA	A(5)	NA	A	A	A
CPVC-41(3)	--	A(2)	A	NA	A	--	--
PVC(3)	A(5)	NA	A(5)	NA	A	A	A
PVC Thin Wall	NA	NA	NA	NA	NA	NA	A
Polybutylene(3)	A	A(2)	A	NA	A	A	A
Polyethylene(3)	A(5)	NA	A(5)	NA	A	NA	NA
Styrene Rubber	NA	NA	NA	NA	A	A(6)	NA
VC PIPE	A(1)	--	--	NA	A(1)	A(6)	--

A = Acceptable NA = Not acceptable -- = Not applicable

Notes:

(1) When manufactured to service designated.

(2) Install without joints in or under slab floors.

(3) Must confirm to UM Bulletin.

(4) Protected when installed underground.

(5) For cold water only, outside dwelling or in unfinished basement or crawl space.

(6) Outside dwelling only.

(7) Brazed joint only.

(8) Dielectric connectors shall be used between ferrous and non-ferrous piping in water piping systems.

515–8.2 *Storage Tanks*

Water storage tanks shall be watertight, sound, not subject to excessive corrosion and capable of withstanding the loads imposed. Tank material and any interior protective coatings used shall not impart toxicity, undesirable tastes, or odors to the water.

515–8.3 *Water Conditioners*

Water conditioners, when provided, shall meet the standards for construction, rated capacity, and installed capacity of WQA S–100.

515–8.4 *Water Filters*

Water filters for sediment removal, taste and odor removal, oxidizing, and neutralizing, when provided, shall meet WQA S–200.

515–9 Sewage Disposal System

Except as modified herein, materials and equipment for sewage disposal system shall comply with the applicable standards referenced in Appendices C, F, and the nationally recognized model code having jurisdiction in the area. State and local codes which deviate from nationally recognized plumbing codes or standards in order to satisfy local conditions may be accepted by HUD if such deviations are identified and substantiated with satisfactory engineering data.

516 *Electrical*

All electrical equipment including motors, heat generating devices, controls, etc., shall comply with the National Electrical Code and with applicable nationally recognized standards and shall be labeled and listed as applicable by an independent inspection agency.

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600 *General.*

All dwelling construction shall assure that the load-bearing portion of the home shall remain stable and shall maintain its capacity to transmit the imposed live and dead load to the ground. Dwelling construction shall also assure that the building will provide: adequate strength and rigidity, equipment that is safe and of reasonable economy of operation, adequate protection from corrosion, decay, insects and other destructive forces, necessary resistance to the elements including prevention of penetration and generation of excessive noise and moisture and limitation on the infiltration of unwanted air dust, necessary durability for the intended life span of the unit assuming reasonable maintenance, construction in accordance with good industry practice which assures quality of materials and workmanship.

600–1 Alternate Construction.

Alternate or special methods of construction, other than those contained herein, may be used when found acceptable by established HUD procedures and Division 613 of this MPS.

600–2 Referenced Standards.

Unless stated otherwise in this MPS, design and construction completed in accordance with the applicable standards listed in Appendix E, Accepted Engineering Practice Standards and Appendix F, Use of Materials Bulletins, shall be considered to satisfy the requirements of this MPS.

601 *General Structural Requirements.*

601–1 Subsurface Soil Exploration.

601–1.1 The scope and type of soil investigation shall be sufficient to permit structural design that will suit the soil conditions present at the building site. Subsurface soil data shall include but not be limited to soil-bearing values, groundwater level, location of rock (if any), and any abnormal soil conditions.

601–1.2 All soils shall be identified by the nomenclature of ASTM D 2487, Classification of Soils for Engineering Purposes, ASTM D 2488, Recommended Practice for Description of Soils or HUD Handbook 4075.8, Engineering Soil Classification for Residential Developments.

601–2 Structural Design.

601–2.1 *General.*

All structural design for buildings and structures shall be based on generally accepted engineering practices. All loadings shall be in accordance with ANSI A58.1 except as shown otherwise in this MPS.

601–2.2 *Earthquake Design.*

Seismic design for buildings in Seismic Zones 2 and 3 shall be in accordance with 1973 Uniform Building Code (UBC). Requirements for seismic design of steel and concrete construction shall also comply with latest standards of American Institute of Steel Construction (AISC) and American Concrete Institute (ACI), respectively. Special attention shall be paid to connections of masonry veneers, chimneys, and appendages, and to design of slit-level, multi-level, or irregularly shaped construction in Seismic Zones 2 and 3.

601–3 Design Dead Loads.

In calculating the dead loads, the actual weight of the material making up the construction shall be used, except as otherwise specified herein. Partitions and other known loads caused by special installation, such as stationary equipment shall be included in arriving at the applicable dead loads. Where a choice of materials is permitted, design dead loads shall be based on the heavier material except that design dead load for resistance to uplift, overturning or displacement shall be based on the lighter material.

601–4 Design Live Loads.

601–4.1 *General.*

Design live loads shall consist of the weight of all moving and variable loads that may act on the building or other structures including loads on floors, operational loads on roofs and ceiling, but not including wind, snow, earthquake or dead load. The design live loads specified herein are min.

601–4.2 *Floor and Ceiling Loads.*

Design live floor and ceiling loads shall be not less than the uniformly distributed loads shown in Table 6–1.1.

601–4.3 *Concentrated Loads.*

Consideration shall be given to effect of concentrated wheel loads on structures.

Floors in garages or portions of buildings used for storage of passenger cars for not more than nine passengers shall be designed for the designated uniform live loads of Table 6–1.1 or 2,000 lb acting on an area of 20 sq in.

601–4.4 *Roof Loads (Also see Snow Loads and Wind Loads).*

Design live roof loads shall not be less than the uniformly distributed loads shown in Table 6–1.2.

TABLE 6–1.1—FLOOR OR CEILING LIVE LOADS

Location	Live Load (psf)
Dwelling rooms (other than sleeping quarters)	40
Dwelling rooms (sleeping quarters and attic floors)	30
Ceiling joist-attics (served by permanent or disappearing stair)	30
Ceiling joist-attics (limited storage roof slope over 3 in 12)	20
Ceiling joists-attics (without storage roof slope 3 in 12 or less)	10
Stairs	60
Public stairs and corridors (two family dwellings	60
Garages and carports (passenger cars)	75(1)
Balconies and porches	60
Sidewalks and driveways	250

Note:
(1) See 601–4.3, Concentrated Loads

TABLE 6–1.2— ROOF LOADS

Roof Slopes	Live Load (psf)(1)
Slope 3 in 12 or less:	
Min. load	20
Roof used as deck	40
Slope over 3 in 12:	
Min. load	15

Note:
(1) psf on horizontal projection of roof area.

601–5 Snow Loads.

Where unusual snow loading conditions occur producing loading in excess of those shown under Roof Loads, higher loads are required in accordance with ANSI A58.1, Minimum Design Loads in Buildings and Other Structures.

601–6 Wind Loads.

601–6.1 *General.*

Min. design wind pressures required herein apply to areas designated as experiencing basic wind speeds up to and including 80 mph as shown in Fig. 6–1.1 and to buildings and structures not over 30 ft in height above finish grade assuming exposure C as defined in ANSI A58.1.

601–6.2 *Minimum Design Wind Pressure Criteria.*

a. Buildings (for overturning racking or sliding); p = 20 psf min.

b. Chimneys, p = 30 psf

c. Exterior walls, p = 15 psf inward or outward. Local pressure at corners of walls shall be not less than p = 30 psf outward. See Note (1) of this section.

d. Partitions, p = 20 psf inward or outward

e. Windows, p = 20 psf inward or outward

f. Roof, p = 20 psf inward or outward

Roofs with slopes greater than 6 in 12 shall be designed to withstand pressures acting inward normal to the surface, equal to the design wind pressure for exterior walls.

Overhanging eves, cornices, and ridges, 40 psf upward normal to roof surface. See Note (1) of this section.

Net uplift shall not be less than 12 psf.

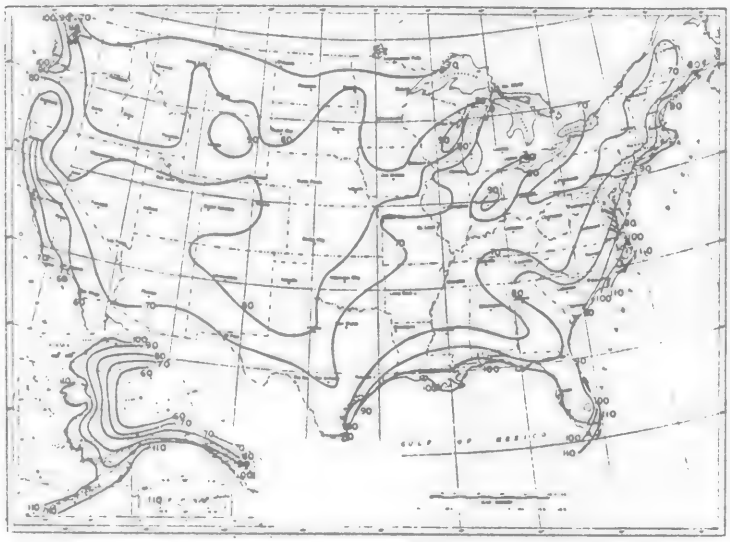
Note (1):

These local pressures shall not be included with the design pressure when computing overall loads. The pressures shall be applied perpendicularly outward on strips of width equal to 10 percent of the least width of building.

601–6.3 *Severe Wind Design Pressures.*

If the construction is higher than 30 ft, or if it is located in an area experiencing wind speeds greater than 80 mph, higher design wind pressures than shown in 601–6.2 are required. Use ANSI A58.1 for higher criteria.

FIG. 6-1.1--BASIC WIND SPEED



BASIC WIND SPEED IN MILES PER HOUR. ANNUAL EXTREME-MILE 30 FT ABOVE GROUND, 50-YR. MEAN RECURRENCE INTERVAL.

Source: ANSI A58.1

Pressures are assumed to act horizontally on the gross area of the vertical projections of the structure exeept as noted for roof design.

601-7 Railing Loads.

Railings around stair wells and at the edges of exterior and interior balconies shall be designed to resist a lateral force applied at the top of the railing of 50 lb per linear ft and a vertical load of 100 lb per linear ft. Anchorage of railing to the structure shall be capable of developing the design loads increased by an impact factor of 100 percent without failure.

601-8 Soil and Hydrostatic Pressure Loads.

601-8.1 *Lateral Pressure on Below Grade Walls* (Basements, Retaining Walls, etc.).

Provision shall be made for lateral pressure of the soil with due allowance for possible surcharges from fixed or moving loads. When a portion, or the whole, of the adjacent soil is below the free ground water surface, computations shall be based on the weight of the soil diminished by buoyancy, plus the full hydrostatic pressure.

601-8.2 *Uplift on Floors.*

Basement floors that may be below the specified frequency normal high ground water elevations indicated in 310-2 shall be designed for the full hydrostatic pressure applied to the bottom of the slab.

601-8.3 *Freestanding Retaining Walls.*

The moment of stability for overturning shall be not less than 2 times the overturning moment and the resistance to sliding shall be at least 1½ times the sliding force.

601-9 Earthquake Loads.

In regions where local experience shows loss of life or damage resulting from earthquakes, and in regions located in zones 1, 2, or 3 as shown on Seismic Risk Map of the United States, Figure 6-1.2, buildings and components, or structures shall be designed to withstand the lateral forces provided for in the 1973 issue of the UBC.

601-10 Wall and Partition Design Deflections.

Deflection of exterior curtain walls and interior partitions shall not exceed $\frac{1}{240}$ of the clear height between floors when subjected to the applicable wind load, acting either inwardly or outwardly, in addition to any gravity loads. If plaster or other brittle materials are used, deflection shall not exceed $\frac{1}{360}$ of the clear height.

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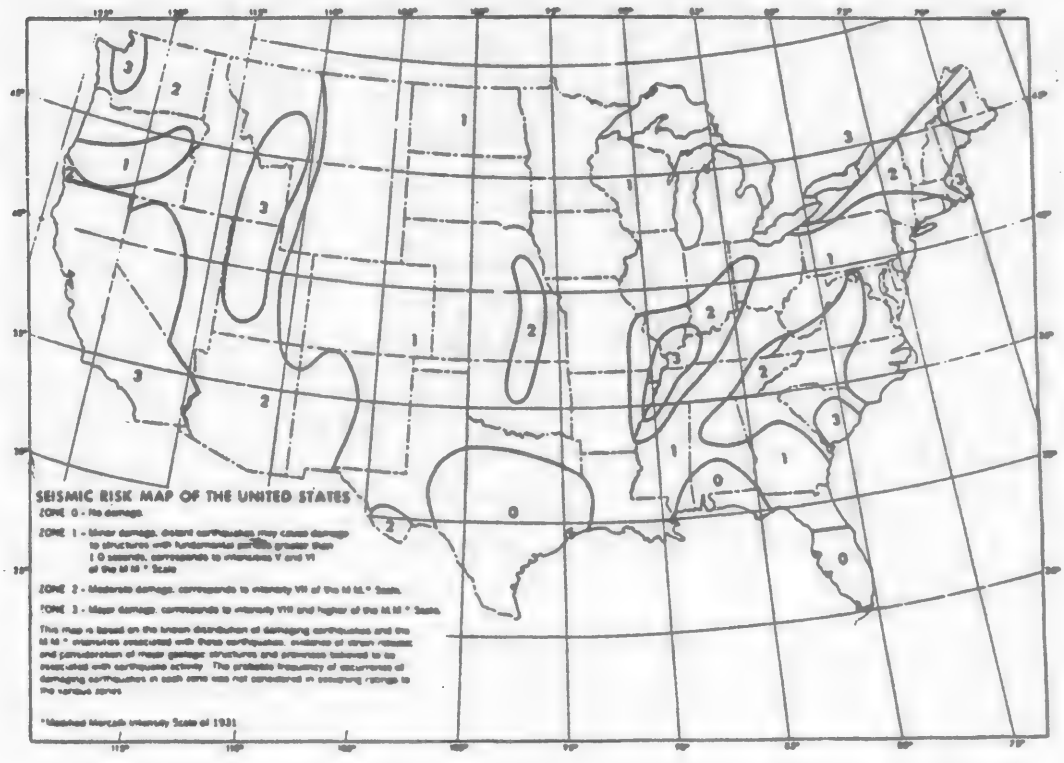
FIG. 6-1.2a---SEISMIC RISK MAP(1)


SEISMIC RISK MAP OF THE UNITED STATES
ZONE 0 - No damage.
ZONE 1 - Minor damage. distant earthquakes may cause damage to structures with fundamental periods greater than 1.0 seconds, corresponds to intensities V and VI of the M.M.* Scale
ZONE 2 - Moderate damage, corresponds to intensity VII of the M.M.* Scale.
ZONE 3 - Major damage, corresponds to intensity VIII and higher of the M.M.* Scale.
This map is based on the known distribution of damaging earthquakes and the M.M.* intensities associated with these earthquakes, evidence of strain released and concentration of major geologic structures and phenomena believed to be associated with earthquake activity. The probable frequency of occurrence of damaging earthquakes in each zone was not considered in assigning ratings to the various zones.
*Modified Mercalli Intensity Scale of 1931.

Source: U.B.C. 1973

Note:

(1) Puerto Rico and Virgin Islands Zone 3

FIG. 6-1.2b——SEISMIC RISK MAP

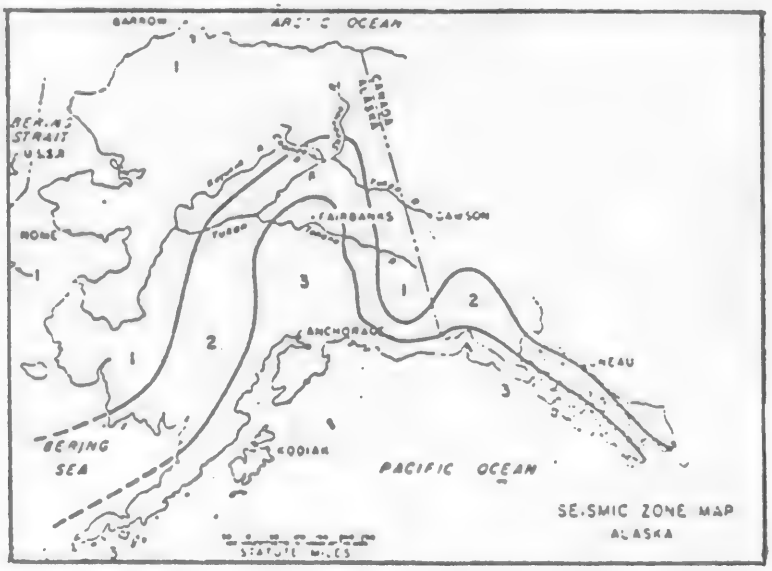
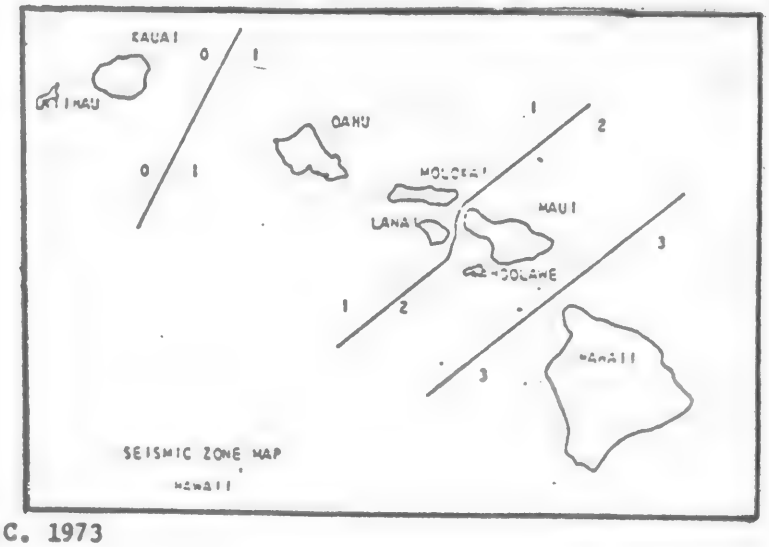


FIG. 6-1.2c



Source: U.B.C. 1973

BILLING CODE 4210-01-C

601–11 Foundations.

601–11.1 *General.*

Foundations shall be proportioned to assure that the following objectives will be attained:

a. Loading of the soil supporting the selected type of foundation will not cause it to fail.

b. Foundations will be properly designed so that their structural failure is prevented.

c. The total settlement of the building will not be excessive so as to impair the usefulness of the structure.

d. The differential settlement between parts of the building will be controlled so that structural damage or inconvenience in service will not occur.

e. Neighboring structures will not be adversely affected by proposed construction.

601–11.2 *Excavation and Backfill.*

a. Excavation for footings or foundation walls shall extend at least 6 in. into natural undisturbed soil which will provide adequate bearing or to stable rock formation.

Exterior wall footings or foundation walls including those of accessory buildings shall extend a min. of 6 in. below the finished grade and where applicable, the prevailing frost line.

b. Basementless Spaces (Crawl Space).

(1) Ground level shall be at least 18 in. below bottom of wood floor joists and 12 in. below bottom of wood girders except when pressure treated wood is used for these members. Where it is necessary to provide access for maintenance and repair of mechanical equipment located in the underfloor space, the ground level in the affected area shall be not less than 2 ft below wood floor joists.

(2) The interior ground level shall be above the outside finish grade unless:

(a) Adequate gravity drainage to a positive outfall is provided or

(b) The permeability of the soil and the location of the water table is such that water will not collect in the basement less space.

(3) When drainage is necessary, the surface shall be properly sloped.

(4) Where soil and moisture conditions warrant, or when specifically required herein, surface shall be covered with a vapor barrier material. See 607.

c. Backfill.

Material used for backfill shall be clean and free of wood scraps or other deleterious substances and shall be placed carefully against walls and shall be well compacted.

601–11.3 *Footings.*

a. Wall Footings.

(1) All exterior walls, bearing walls, columns, and piers shall be supported on continuous solid masonry or concrete footings, or other acceptable structural systems which shall be of sufficient design to support safely the loads imposed as determined from the character of the soil, and shall in all cases extend below the frost line.

Foundation walls shall extend at least 8 inches above the finished grade adjacent to the foundation at all points.

(2) Min. thickness shall be 6 in., and unless reinforced, not less than 1½ times the footing projection.

(3) Footings poured integrally with wall, flared or otherwise, may be used when properly designed and when soil and climate conditions permit trench foundations. The slope of flare shall be not less than 60 degrees from horizontal.

b. Stepped Wall Footings. Vertical step shall not exceed ¾ of the horizontal distance between steps. Horizontal distances between steps shall be not less than 2 ft.

Horizontal and vertical steps shall be placed monolithically. Vertical connection shall be the same width as the footing and not less than 6 in. in thickness.

c. Pier, Column and Masonry Chimney Footings. Min. thickness 8 in., except 12 in. for chimney footings and unless reinforced, not less than 1½ times the footing projection.

d. Footing Reinforcing. Reinforce footings when the projection on each side of wall, pier or column exceeds ⅔ of the thickness, or when required because of soil conditions.

e. Depth for High Volume Change Soils. Foundations of structures located in areas known or determined to contain soils of high volume change potential shall be designed in accordance with the recommendations of a qualified engineer.

601–11.4 *Foundation Walls.*

a. General. These standards apply to concrete or masonry walls below grade. Pressure-treated wood foundations shall comply with standards referenced in Appendix E. Basement or foundation wall cracks shall not be greater than ⅛ in. in width.

b. Top Course Capping.

(1) Walls of hollow masonry shall be capped with 4 in. solid masonry or concrete or shall have cells of top course filled with concrete or grout. Capping may be omitted where a sill plate which bears on both inner and outer face shells is provided.

(2) Where a continuous concrete cap is required for termite protection, it shall be reinforced in accordance with Division 603 and 606–2.2c.

(3) Cap walls of hollow masonry units under girders, min. thickness, 6 in.

c. Min. Thickness. Thickness of foundation wall shall be not less than that of wall supported except that exterior walls of masonry veneer over frame construction may be corbeled 1 in. max.

Min. thickness shall be that required to resist lateral pressure from adjacent earth and to support design loads. When thickness is not determined by a structural analysis, wall shall be as required by the HUD field office.

Upper portion of foundation wall may be reduced in thickness to 4 in. to permit placement of veneer or may be sloped to permit edge of concrete floor slab to be covered by base trim. When the 4 in. portion exceeds 4 in height, reinforcing shall be provided. Max. height of 4 in. portion, 12 in unless veneer is bonded to wall.

d. Reinforcement.

(1) Where earthquake design is required, and in seismic zone 2 or 3, reinforce foundation walls under the following conditions:

Concrete walls when height exceeds 6 times thickness.

Masonry walls when height exceeds 4 times thickness.

(2) Size and spacing of reinforcement shall be in accordance with accepted engineering standards.

e. Pilasters.

(1) Pilasters shall be provided under girders framing into walls in all 6 in. concrete or masonry walls and in all 8 in. hollow masonry walls unless engineering analysis indicates that pilasters are not needed. Pilasters shall be bonded into wall.

(2) Min. Size: Concrete, 2 in. x 12 in. Masonry, 4 in. x 12 in.

f. Dampproofing.

Leaks which permit a measureable penetration of water, by seepage or trickling, through basement or foundation walls are not acceptable. Basement walls shall be drained and dampproofed in accordance with 607.

601–11.5 *Masonry or Concrete Foundation Piers.*

Pier construction shall assure safe support of all design loads.

a. General.

These standards apply to free-standing pier construction, exterior pier and curtain wall construction, and to grade beam and pier construction.

Where unstable or expansive soil conditions require special foundation design, the design and construction shall be in accordance with accepted engineering practice.

b. Free Standing Pier Constructions.

(1) Piers supporting wood frame construction shall extend at least 8 in. above finish grade. In seismic zones 2 and 3, piers shall be reinforced as required by the HUD field office.

(2) Exterior Piers. Piers supporting exterior walls or interior piers subject to wind shall be concrete, solid masonry, or hollow masonry with cells filled with concrete or grout.

Max. height above grade, 3 times their least dimension unless reinforced.

(3) Interior Piers. Piers supporting interior construction and not subject to wind may be concrete, solid masonry or hollow masonry with cells of top course filled with concrete or grout.

Max. height above grade unless reinforced:

Concrete or solid masonry, or filled cell masonry, 10 times their least dimension.

Hollow masonry, 4 times their least dimension.

(4) Pier Size. Size and spacing of piers and size of footing shall be as required to support design load. When this determination is not based upon a structural analysis, piers shall be as required by the HUD field office.

c. Exterior Pier and Curtain Wall Construction.

(1) Piers and curtain walls supporting wood frame construction shall extend at least 8 in. above finish grade unless wood framing is of treated wood or a decay resistant species.

(2) Exterior pier and curtain wall construction shall not be used where basement space is provided. Provide foundation wall.

(3) Max. height of piers above footing, unless reinforced:

Concrete or solid masonry, 10 times their least dimension.

Hollow masonry, 4 times their least dimension.

(4) Max. height of curtain wall above footings:

Concrete or solid masonry, 14 times thickness of curtain wall.

Hollow masonry, 10 times thickness of curtain wall.

(5) Unbalanced fill against 4 in. curtain wall shall not exceed 2 ft.

(6) Curtain walls shall be bonded or anchored into piers and be supported on footings integral with pier footings. Footings may be omitted if curtain walls are reinforced to span between piers.

(7) Brick veneer, not more than 1½ stories in height, may be supported on curtain wall.

d. Grade Beam and Pier Construction.

(1) Grade beam and piers supporting wood frame construction shall extend at least 8 in. above finish grade unless wood framing is of treated wood or a decay resistant species.

(2) Bottom of grade beam shall extend below frost line established for the area except when one of the following conditions assures that damage by frost action will not occur:

Soil is of such a nature that moisture will not be retained under grade beam. Where the susceptibility of the soil to frost action is not known, soil analysis will be required by the HUD field office.

Soil under grade beam is removed to below frost line and replaced with coarse rock or gravel or other material not susceptible to frost action. When trench is excavated in an impervious soil, drain tile to a positive outfall shall be required.

(3) Design of grade beam and piers shall be in accordance with accepted engineering practice standards.

601–11.6 *Slabs-on-grade.*

a. Slab-on-ground construction shall not be used on sites having a ground water condition near the ground surface. Site grading and drainage around the structure shall be such that surface or ground water will not collect under the slab. Where ground or surface water presents a problem, a positive system of underground drainage shall be required.

Where unstable or expansive soils require special slabs, design and construction shall be in accordance with recognized engineering practice acceptable to HUD.

Slabs may be designed as ground-supported framed slabs deriving principal support from the subgrade or as structural slabs independent of fill. Selection of slab type shall be in accordance with BRAB 'Criteria for Selection and Design of Residential Slabs-on-Ground Used on Expansive or Compressible Soils.' Design of all structural framed slabs shall be in accordance with Building Code Requirements for Reinforced Concrete (ACI–318).

Variation in slab design are acceptable where soils investigation of the building site, climatic rating and engineering design and analysis by a registered professional engineer indicate that a slab of lighter or heavier design is suitable. Soil investigation and construction procedures shall be in compliance with applicable provisions of the BRAB criteria.

601–11.7 Framed Slabs (Structural Slabs).

Slabs may be designed as ground supported structural slabs deriving their principal support from subsurface soils or as framed slabs independent of fill. Design of all structural framed slabs shall be in accordance with Building Code Requirements for Reinforced Concrete ACI–318. Min. thickness shall be as required by design but not less than 4 in.

601–12 Foundations in Seismic Regions.

Buildings and structures located in seismic zone 2, or 3 Figure 6–1.2, are subject to earthquake effects and require special foundation design considerations. See Appendix E.

601–13 Structural Safety From Progressive Collapse.

Buildings shall reflect a level of safety against progressive collapse. Structural failure in a relatively small area of a building shall not precipitate partial or total collapse of a building. Design shall demonstrate the existence of alternate paths of support or of sufficient strength and ductility to provide for unexpected severe overload due to an explosion, fire, impact, differential settlement or similar effect.

602 *Site.*

602–1 General.

Site work shall be accomplished in accordance with generally accepted good construction practices. Work shall reflect use of methods, materials and equipment which are safe and suitable for the intended purpose.

602–2 Stability of Slopes and Embankments.

The min. acceptable factor of safety with respect to sliding shall be 1.5 based on generally accepted methods of analysis. A stability factor greater than 1.5 may be necessary when the potential for catastrophic loss is present, such as below large dams. The most adverse conditions concerning, weight and strength of soil, unbalanced water pressure, percolating water, weight of equipment, structures or materials, and other significant factors such as the effects on soil strength and other soil properties changes caused by dynamic loading from earthquakes shall be reflected in the analysis.

602–3 Soil Treatment.

Wood and other vulnerable materials shall be protected from termites in those areas where damage has been experienced or may reasonably be anticipated. When soil treatment is used, the rate of application of the approved chemicals shall be not less than that recommended by the U.S. Department of Agriculture publication, entitled Subterranean Termites, Home and Garden Bulletin No. 64. Chemical soil treatment shall not be used where there is a possibility of contamination of a water source or supply or the living area of crawl-space-plenum houses. (See 606–2).

602–4 Site Utilities—Underground Utilities.

602–4.1 Underground piping and related items shall be protected from corrosion. Underground mechanical and electrical systems shall be protectively coated to minimize corrosion where soil conditions warrant. Where applicable, sacrificial anodes may be used.

602–4.2 Sacrificial anodes may be used where soil resistivity does not exceed 15,000 ohm—centimeters. Otherwise, an impressed current system of corrosion prevention shall be used.

602–4.3 Site work construction for utility systems shall also be completed in accordance with requirements in 615 and 616.

602–4.4 Underground utilities servicing more than two dwelling units shall not be located beneath buildings.

602–5 Roads and Walks.

602–5.1 *General.*

Surfaces and base courses for roads, streets, parking areas and walks shall be of durable materials and construction shall be in conformance with generally accepted local design practices and this MPS.

602–5.2 *Drainage.*

Adequate surface and underground drainage systems shall be required to serve all paving and the improvements as necessary to insure continuing stable soil support for these improvements.

602–5.3 *Curbs and Gutters.*

All pavement shall be protected at the edges by curbs, gutters, curbs and gutters, or other suitable means to prevent ravelling of the pavement edge and to provide an adequate drainage-way for surface runoff.

603 *Concrete.*

603–1 General.

Concrete construction shall be such as to provide safe and durable support of all design loads, and of a quality to resist deterioration due to weather or other deleterious exposure. Concrete surfaces shall not disintegrate—pit, scale or spall—to the extent that the aggregate is exposed under normal conditions of weathering and use. Concrete surfaces shall not powder or chalk.

603–2 Joints.

a. Construction Joints. Joints shall be made and located so as not to impair the strength of the structure.

b. Isolation (Expansion) Joints. Joints shall be used to separate different parts of the structure to permit both horizontal and vertical differential movements.

c. Control (Contraction) Joints. Joints shall be used to provide for construction caused by drying shrinkage.

d. Concrete slabs shall not contain excessive cracks and voids at expansion and contraction joints.

603–3 Proportioning and Mixing.

603–3.1 *Proportioning.*

Proportions of cement, fine and coarse aggregate and mixing water shall be selected to produce concrete of the required placeability, durability, workability and strength, and other required properties. Except as shown otherwise in this standard, ACI 301, Specifications for Structural Concrete or ACI 318, Building Code Requirements for Reinforced Concrete, shall be utilized to proportion ingredients for concrete. Concrete shall have a compressive strength f'c, at 28 days, of at least the required design strength not less than that shown in Table 6–3–1.

603–3.2 *Mixing.*

Materials for concrete shall be thoroughly mixed to assure that a uniform distribution of all material has been achieved.

603–3.3 *Concrete Quality.*

a. Water-Cement Ratio. The max. water cement ratios shall be in accordance with ACI 301.

b. Slump.

(1) Max. slump, measured by ASTM C143 standard test, shall not exceed 4 in. for normal weight concrete if consolidation is to be by vibration, 5 in. if consolidation is by other means.

(2) Slump for lightweight aggregate concrete shall not exceed 3 in.

c. Air-Entraining—Durability. Air-Entrained concrete is required for concrete exposed to freezing and thawing. Unless plant or transit-mix concrete is used, air entrained concrete shall be obtained by the use of cement to which an air-entraining agent has been added by the cement manufacturer. Air content shall be between 5 and 7 percent of the volume of concrete.

d. Admixtures and Calcium Chloride. Use of these materials shall be in accordance with ACI-301.

TABLE 6-3.1—MINIMUM COMPRESSIVE STRENGTH, f'c AT 28 DAYS (psi)
(Plant or Transit Mixed)

Type or Location of Concrete Construction	Regional Weathering Areas (1)		
	Negligible	Moderate	Severe
	f'c	f'c	f'c
Basement walls and foundation not exposed to weather.	2000	2000	2000
Basement slabs and interior slabs on grade.	2500	2500	2500
Basement walls, foundations, exterior walls, and other concrete work exposed to weather.	2500	3000	(2) 3500
Driveways, curbs, walks, patios, porches, and garage floors, exposed to weather.	2500	(2) 3000	(2) 3500

Notes:

(1) See Figure 6-3.1 for weather areas. Page 6-18.

(2) Air entrained concrete only.

603-4 Interior Concrete Slabs-on-Ground.

603-4.1 *General.*

a. Slabs shall be designed and constructed in accordance with ACI 302, Recommended Practice for Concrete Floor and Slab Construction, except as shown otherwise in this MPS.

b. Basement floor cracks shall not exceed 3/16 in. in width or 1/8 in. in vertical displacement.

c. Concrete floor in a basement or in a habitable room shall not have pits, depressions or areas of unevenness that would prevent its use as a finished floor.

d. The floor slope, unless designed for specific drainage purposes, shall not exceed 1/240 of the room width.

e. Cracks in concrete slab-on grade floors shall not significantly impair the appearance or performance of the finish flooring material when the finish flooring is in place.

f. Cracks in attached garage slabs shall not exceed 1/4 in. in width or 1/4 in. in vertical displacement.

603-4.2 *Slabs on Fill Within Foundation Walls.*

a. Preparation of Areas. Areas within foundation walls shall have all vegetation, topsoil and foreign material removed. Fill material shall be free of vegetation and foreign material.

b. Slabs on Highly Compacted Fill.

(1) Fill shall be compacted to a density that will assure zero consolidation and 2 percent max. heave under slab or footing loads. Max. thickness of compaction layers shall be 6 in. except where compaction equipment of demonstrated capability is used and where compaction is under the direction of a qualified engineer, deeper layers may be permitted.

(2) Max. depth of fill below slab or base course, if provided, depends upon type of soil, degree of compaction and type of compaction equipment used. Under normal compaction methods, fill depths shall not exceed the following: (soil types based on the HUD Handbook 4075.8).

Clean sand or gravel: Soil types GW, GP, SW, and SP, 24 in.

Other sands or gravel: Soil types GM, GC, and SC, 12 in.

Inert silts and clays: Soil types ML, and CL, 8 in.

(3) Organic or active clays and silts of the OL, MH, CH, OH and PT groups shall not be used for support of slabs on grade.

(4) Where soil is placed and compacted under the direction of qualified engineer, fill depths may be increased.

c. Slabs on Moderately Compacted Fill. Structural slabs supported at edges and through the center by piers or intermediate foundation walls require only moderate compaction.

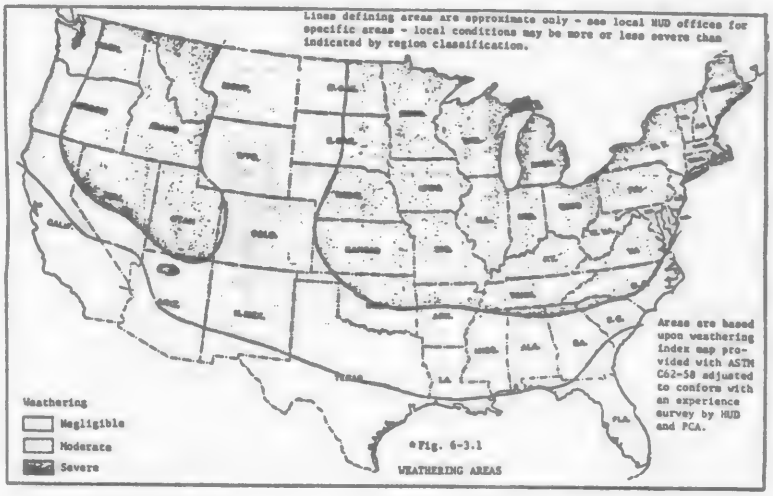
Concrete slabs and piers shall be designed in accordance with ACI 318, Building Code Requirements for Reinforced Concrete.

603-4.3 *Dampproofing Slabs-on-Ground.*

a. General.

Concrete slab-on-ground in habitable areas may require precautions to be taken to prevent damage to flooring materials by moisture or vapor. Habitable area is considered to apply to the entire floor slab within the dwelling except basement floors and floors of built-in or attached garages.

FIG. 6-3.1—WEATHERING AREAS


Lines defining areas are approximate only - see local HUD offices for specific areas - local conditions may be more or less severe than indicated by region classification.
Areas are based upon weathering index map provided with ASTM C62-58 adjusted to conform with an experience survey by HUD and PCA.
Weathering
Negligible
Moderate
Severe
*Fig. 6-3.1
WEATHERING AREAS

b. Slabs Above Grade.

(1) Height above finish grade:

Top of slab shall be at least 8 in. above finish grade.

Bottom of wood sills or sleepers below top of slab shall be at least 8 in. above exterior finish grade.

(2) Slabs not having ductwork or piping in or under slab shall comply with Table 6–3.2.

(3) Slabs having ductwork or piping in or under slab shall comply with Table 6–3.2, except that a continuous vapor barrier shall be installed under slab and ductwork in all cases.

c. Slabs Below Grade (Habitable Areas).

Flooring materials used on below grade slabs shall be Group A, as shown in Table 6–3.2, except that Group B flooring materials may be used when specifically recommended by and installed in accordance with the flooring manufacturers recommendations. Install a continuous membrane below slab. Membrane shall be turned up at edges, to top of slab. Provide a 4 in. base course of limited capillarity under slab. Foundation drains and waterproofing of foundation walls enclosing habitable areas below grade shall be required. See 607–2.

d. Slabs Below Grade (Not Habitable Areas).

Where Group A or B flooring materials are proposed for use on concrete slabs below grade, other than habitable areas, comply with 603–4.4c.

e. Base Course.

(1) Base courses of limited capillarity materials, when required, shall be at least 4 in. in thickness.

(2) Base course materials shall be clean graded gravel, crushed rock or crushed blast furance slag. Material shall pass a 2 in. sieve and be retained in a ¼ in. seive.

Where white alkali (sodium sulphate) concentrations exceed 0.1 percent in natural surface soils, base course materials shall pass a 2 in. sieve and be retained on a ½ in. sieve.

(3) Materials other than the above may be used when test results are provided indicating that the capillary rise of liquid water in a 4 in. sample of the material will not exceed 2 in. in 24 hr.

TABLE 6–3.2—FLOORING ON CONCRETE SLABS

Type of Flooring	Vapor Retarders see 603–4.3a	Base Course see 603–4.3e
Group A Asphalt Tile Rubber Tile Vinyl-asbestos Tile Vinyl Tile Terrazzo Ceramic Tile	Provide (1)	Not required (2)
Group B Vinyl Sheet Rubber Sheet Cork Tile Linoleum Tile Vinyl-cork Tile Concrete, stained or painted Carpet	Provide	Provide
Group C Wood Block Wood Strip	Provide (3)	Provide

Notes:

(1) In arid regions where irrigation and heavy sprinkling is not done, and where no drainage or soil problem exists on the site, vapor barrier may be omitted when acceptable to the HUD field office.

(2) Base course should be used when capillarity of subsoil is such that liquid rise from ground water table will permit water to reach bottom of slab.

(3) Vapor retarders may be installed either under or on top of slab.

603–4.4 *Min. Thickness of Slab-on-Ground.*

a. Except where otherwise permitted herein, interior concrete slabs-on-ground shall be at least 4 in. in thickness.

b. Where slab-on-ground are placed in two operations (double slabs) min. thickness of upper slab, 3 in; lower slab, 2 in.

c. Min. slab thickness for basements or areas requiring no floor finsih shall be 3 in.

603–5 Exterior Concrete Slabs-on-Ground.

603–5.1 *Garage and Carport Slabs.*

Slabs shall be at least 4 in. thick.

603–5.2 *Walks.*

Slabs shall be at least 3 in. thick.

603–5.3 *Porches and Entrance Slabs.*

a. Slabs shall be at least 4 in. thick. Slab shall be anchored to or supported at foundation wall by anchors, piers or corbels built with wall. Outer edge of slab shall be supported on foundation wall or grade beam and piers if soil under slab is uncompacted fill or is susceptible to excessive expansion or frost action. Surface of slab shall be sloped to drain away from foundation. For structural slabs, see 603–6.

b. Stoops or steps shall not settle or heave in excess of 1 in. in relation to the house structure. Cracks shall not exceed 1/16 in.

604 *Masonry.*

604–1 General.

Masonry construction shall be such as to assure safe and adequate support of all design loads, to prevent the passage of water or moisture, and to resist deterioration due to weather or other deleterious exposure.

604–1.1 *Design and Construction.*

a. Engineered Masonry Construction shall be designed and constructed in accordance with one of the referenced standards except for modifications stated in the MPS.

Exception: In cases where the design is based on allowable stresses predicated on "with inspection" provisions, it is required that qualified masonry inspection be provided on a continuous basis, whenever masonry is being placed.

b. Earthquake Areas.

(1) Unreinforced masonry shall not be permitted in seismic zones 2 and 3 but may be permitted in seismic zones 1 and 0 if masonry is designed to resist the seismic forces.

(2) Reinforced masonry shall contain at least the amount of reinforcement required by design but not less than the min. stated herein.

c. High Wind Areas. Exterior masonry walls in areas experiencing wind speeds greater than 80 mph shall be designed in accordance with 604–1.1a.

Min. Reinforcement. Masonry walls subject to wind loads of 30 psf and over or located in seismic zone 2 or 3 shall have at least the following amount of steel reinforcement:

Min. area of reinforcement = 0.002 times the gross crosssectional area of the wall, not more than two-thirds of which may be used in either direction. Min. bar size—⅜ in dia. for vertical reinforcement; max. spacing 4 ft oc.

e. Provisions for foundation walls are covered in 601.11.4.

604–1.2 *Bonding.*

a. Masonry walls shall be laid in a running bond pattern with units regularly breaking joints with the course below except as noted for stacked bond.

b. Stacked bond may be used provided walls are reinforced horizontally with continuous joint reinforcing 16 in. oc and bonded to backing. The longitudinal bars or wires of such reinforcement shall be not less than No. 9 ga and at least one longitudinal bar or wire shall be provided for each 6 in. of wall thickness or fraction thereof.

c. Intersecting masonry walls shall be bonded or anchored together.

d. Bonding of Non-reinforced Walls, Except Veneer. The facing and backing in walls of more than one unit or wythe thickness shall be bonded together.

(1) Multiple-wythe non-reinforced brick masonry loadbearing and non-loadbearing walls shall be bonded with masonry bonding units or with corrosion-resistant metal ties as specified in this section.

(2) Bonding with Masonry Headers. Where the facing and backing of solid masonry construction are bonded by means of masonry headers, no less than 4 percent of the wall surface of each face shall be composed of headers extending not less than 3 in. into the backing The distance between adjacent full length headers shall not exceed 24 in. either vertically or horizonatally. In walls in which a single header does not extend through the wall, headers from the opposite sides shall overlap at least 3 in. or headers from the opposite sides shall be covered with another header course overlapping the header below at least 3 in.

(3) Bonding with Metal Ties. The facing and backing (adjacent wythe) of masonry walls shall be bonded with corrosion-resistent 3/16 in. diameter steel ties or metal wire of equivalent stiffness embedded in the horizontal mortar joints. There shall be one metal tie for not more than each 4½ sq ft of wall area. Ties in alternate courses shall be staggered; the max. vertical distance between ties shall not exceed 24 in.; and the max. horizontal distance shall not exceed 36 in. The ends of ties shall be bent to 90 degree angles to provide hooks not less than 2 in. long or ties bent to a rectangular shape shall be used. Additional bonding ties shall be provided at all openings spaces not more than 3 ft apart around the perimeter and within 12 in. of the opening.

604–1.3 *Masonry Support.*

Masonry shall be supported on masonry, concrete, steel or on systems conforming to standards referenced in Appendix E.

604–1.4 *Lintels.*

Masonry over openings shall be supported by steel lintels, reinforced concrete or masonry lintels or masonry arches, designed to support load imposed.

604–1.5 *Joints.*

a. Max. average thickness of mortar joints shall be ½ in.

b. Solid masonry shall be laid in full bed and head joints.

c. Hollow masonry shall be laid with mortar applied to bed and head joints of face shells except that first course shall be laid in full mortar bed.

d. All exterior joints shall be tooled unless surface is to receive stucco or is otherwise acceptable to the HUD field office. All exposed interior joints shall be tooled.

e. Cracks in mortar joints of masonry walls or veneer shall not exceed ⅛ in. in width.

604–1.6 *Joint Reinforcement (Temperature and Shrinkage).*

a. Continuous joint reinforcement (temperature and shrinkage) is required in all concrete masonry walls and walls with concrete brick veneer exceeding 20 ft in length between corners or control joints. Max. length of wall between corners or control joints shall be 50 ft. Max. spacing of joint reinforcing shall be 16 in. oc.

b. The above applies to concrete masonry walls of either concrete units or concrete brick, except when used as backup for clay brick facing. If high-pressure steam cured masonry units or brick is used, max. length of wall without joint reinforcement, 30 ft.

c. In addition to this joint reinforcement and regardless of length of wall, provide strips of joint reinforcement in the first and second bed joints immediately above and below each opening. The strips shall extend 24 in. beyond each side of the opening.

604–1.7 *Chases and Recesses.*

a. Chases and recesses shall be constructed at the time wall is laid. In exterior walls back of chases shall be dampproofed and insulated.

b. Recesses:

(1) Max. depth in 8 in. walls, 4 in.

(2) Max. width, 30 in. except when under windows.

(3) Max. height, 24 in. except when under windows, recess may extend to sill.

(4) Provide steel or reinforced concrete or masonry lintel over recess exceeding 14 in. in width.

c. Chases:

(1) Max. depth in 8 in. walls, 4 in.

(2) Max. width,

Vertical chases, 4 in. except that width may be 12 in. if less than 4 ft. in height.

Horizontal chases, 8 in.

(3) Max. length,

Vertical chases, 8 ft in 8 in. walls.

Horizontal chases, 5 ft except when chase is totally confined to area under window.

(4) When horizontal chases are used, all loads above chase except wall weight shall be supported by a reinforced bond beam and by wall beyond each end of beam. Horizontal chase shall not intersect with a vertical chase.

(5) A horizontal chase for drainage or vent piping may be constructed using the void of a lintel block in lieu of formed chase. Lintel block shall be set upright in the normal manner. Max. length of chase and intersection with vertical chase restrictions do not apply.

(6) Diagonal chases are not acceptable.

604–1.8 *Bond Beams.*

a. Where earthquake design (seismic zone 2, or 3) or design for high winds (30 psf or over) is required, install a continuous beam at each floor or ceiling level. Bond beam shall be cast-in-place concrete or special masonry units designed for this purpose. Beams shall be anchored to wall below in such a manner to equal net design wind uplift.

b. Min. height, 8 in.; min. thickness, same as wall. Reinforce with not less than two No. 4 bars.

c. Roof and ceiling construction shall be anchored to bond beam.

604–2 Exterior Masonry Walls.

604–2.1 *General.*

Exterior masonry wall construction shall assure safe and adequate support of design loads and shall effectively resist entrance of water or moisture.

604–2.2 *Min. Thickness—Height Limitation (Conventional Masonry Construction).*

When height of wall does not exceed 35 ft, at least 8 in. (nominal) thick walls are required and roof construction shall not impart any horizontal thrust to wall.

a. Exceptions. Except where earthquake design is required (seismic zone 2 or 3) 6 in. (nominal) masonry walls may be used for one-story construction provided:

Height of wall does not exceed 9 ft at plate line and 15 ft to peak of gable.

Girders or other concentrated loads are supported on integral piers or pilasters not less than 8 in. x 12 in.

Compliance with other requirements for 8 in. walls is attained.

b. When walls are designed and constructed in accordance with 604–1.1, Engineered Masonry Construction, they shall be considered acceptable.

604–2.3 *Furring.*

Masonry walls less than 12 in. in thickness in habitable spaces shall be furred except that furring may be omitted in areas not subject to wind-driven rain.

Furring shall be at least ¾ in. thick unless type of insulation installed requires additional thickness. Spacing of furring depends upon type of interior finish proposed.

604–2.4 *Plate Anchorage.*

Wood frame roof and ceiling construction shall be anchored to exterior wall or to bond beam, when required by design analysis.

604–2.5 *Base Flashing and Parging.*

a. Except in arid regions, install base flashing at bottom of all walls arranged to deflect any water penetrating outer course or face shell back to the exterior. Where floor joists penetrate masonry wall, install additional row of base flashing at each floor level above joists. On slab-on-ground construction, base flashing may be omitted at bottom of wall provided a built-in offset is formed in the slab at least 1½ in. below top of slab.

b. Base flashing shall be in accordance with 607–5. Provide weep holes approximately 2 ft oc where required.

c. In areas subject to wind-driven rain, wall shall be parged. In walls of two or more unit thickness, parge the exterior face of back-up units; or the interior face of the exterior wythe; or the inner face of the back-up when through wall header bonding is used. In walls of single unit thickness composed of solid units, parge on inside face under furring, except that parging may be omitted when a moisture barrier is used to separate interior finish from masonry. Walls of single unit thickness of hollow units normally do not require parging if care is used in placing mortar on face shells only, leaving crosswebs without through mortar joints.

604–2.6 *Top Course Capping.*

a. Walls of hollow masonry shall be capped with 4 in. solid masonry or concrete or shall have cells of top course filled with concrete or grout. Capping may be omitted where a rafter plate which bears on both inner and outer face shells is provided.

b. Cap walls of hollow masonry units under girders; min. thickness, 6 in.

604–3 Cavity Wall Construction.

604–3.1 *General.*

Cavity wall construction shall consist of brick, structural clay tile or concrete masonry units or any combination of such units in which facing and backing are completely separated except for the metal ties which serve as bonding.

604–3.2 *Min. Thickness—Height Limitations (Conventional Masonry Construction).*

Min. thickness of each wythe, 4 in. (nominal). Cavity shall not be wider than 3 in.

nor less than 2 in. Max. height of wall, having 4 in. wythes, 25 ft.

Exceptions:

(1) Cavity walls shall not exceed 3 stories or 35 ft in height except that wall having 4 in. wythes shall not exceed 2 stories or 25 ft in height.

(2) Cavity walls constructed of clay or shale brick 3 in. for facing or backing or both shall not exceed 9 ft at the plate and 15 ft at a gable end wall.

604–3.3 *Furring.*

Furring of cavity walls it not required unless necessary to meet insulation requirements. Provide weep holes, approximately 4 ft oc at bottom of cavity for drainage.

604–3.4 *Insulation.*

Insulation placed within cavity shall be held at least 1 in. away from exterior wythe unless cavity is dampproofed on face of inner wythe or water proof insulation is used.

604–3.5 *Corbelling.*

Cavity wall construction may be supported on an 8 in. foundation wall provided the 8 in. wall is corbelled with solid masonry to width of cavity wall. Individual corbels shall not exceed 2 in. nor more than ⅓ the height of each corbelling unit.

604–3.6 *Framing Support.*

Floor joists shall bear on solid masonry not less than 4 in. thick and shall not project into cavity. Where girders, beams or other concentrated loads frame into wall, provide a solid masonry pilaster for bearing. Pilaster shall not be less than 8 in. wide and shall bond inner and outer wythes together.

604–4 Interior Masonry Walls.

604–4.1 *Thickness.*

a. Party or lot line walls, 8 in. when height of wall does not exceed 35 ft. When exceeding this height, 12 in.

b. Bearing partitions, 8 in. except when supporting not more than one floor, 6 in.

c. Non-bearing partitions, 3 in.

604–4.2 *Construction.*

a. Loadbearing walls of hollow masonry shall be capped in compliance with 604–2.6.

b. Intersecting masonry wall shall be bonded or anchored together.

c. Pipe chases shall be constructed at time wall is laid in accordance with 604–1.7.

604–5 Masonry Veneer.

604–5.1 *General.*

Provide a durable exterior finish which will effectively resist entrance of water or moisture.

These standards apply to masonry veneer attached to frame or masonry construction.

604–5.2 *Min. Thickness.*

a. Solid Clay and Concrete Brick.

(1) 3 in. and 4 in. nominal, limited to two stories and height not exceeding 20 ft at plate and 28 ft at gable.

(2) 4 in. nominal may be permitted for three stories and height not exceeding 30 ft at plate and 38 ft at gable under the following conditions:

Wall is veneered to masonry back-up without airspace between veneer and back-up, or

Airspace between veneer and sheathing is reinforced with 1 in. grout and reinforced with 2 in. x 2 in. paperbacked welded wire fabric attached to framing with wall ties attached to reinforcement.

(3) Concrete brick shall conform to ASTM C 55, Grade N. Masonry veneer of concrete brick shall be constructed in accordance with 604–1.6.

b. Concrete Masonry Units or Structural Clay Tile. 4 in. nominal. Max. height of wall shall be set forth in a.(1) or a.(2) above.

c. Ashlar Stone—3 in. actual. Max. height shall be as set forth in 604–5.2a, except 3 in. thickness shall be limited to one story.

604–5.3 *Joints.*

Joints in masonry veneer shall comply with applicable requirements for masonry walls.

604–5.4 *Bonding.*

a. Unless otherwise acceptable to the HUD field office, masonry walls shall be laid in a running bond pattern with units regularly breaking joints with the course below.

b. Stacked bond may be used provided walls are reinforced horizontally with continuous joint reinforcing, 16 in oc.

604–5.5 *Anchorage.*

a. Veneer shall be anchored to back-up or to framing with at least the equivalent of 22 ga ⅞ in. wide, corrugated, corrosion-resistant metal ties spaced to assure that all design loads are adequately transmitted to the structure.

b. In areas experiencing wind speeds greater than 80 mph, tie spacing shall be based on 80 lb per tie.

c. Ties shall be embedded at least 2 in. in a horizontal joint and nailed to studs with 8d nails.

604–5.6 *Veneer Over Frame Construction.*

a. Masonry veneer may be corbelled over foundation wall, not to exceed 1 in.

b. Provide 1 in. airspace between veneer and sheathing.

c. Provide 30 lb asphalt-saturated felt or corrosion-resistent metal base flashing. Extend over top of foundation wall from approximate outside face of wall and not less than 6 in. up on sheathing under sheathing paper. If sheathing paper is omitted, install under sheathing for a height of not less than 6 in.

d. Water-resistant building paper or asphalt-saturated felt shall be installed over sheathing except as provided in 606–5.5.

e. Provide weepholes approximately 4 ft oc by omitting mortar in vertical joints at bottom course of veneer.

604–5.7 *Veneer Over Masonry Backup.*

Provide 30 lb asphalt-saturated felt or corrosion-resistant metal, base flashing at bottom of veneer. Extend over top of foundation, up at least 6 in. and embed in back-up course. Provide weepholes approximately 4 ft oc.

Back-up shall be self-supporting and shall comply with standards for masonry walls.

604–6. Masonry Chimneys.

604–6.1 *General.*

Construct and install chimneys which are structurally safe, durable, smoketight and capable of withstanding action of flue gases.

604–6.2 *Construction.*

a. Masonry chimney walls shall be constructed of masonry units with walls not less than 4 in. thick or rubble stone masonry not less than 12 in. thick. Masonry shall be laid with full, push filled, cross and bed, mortar joints. Concrete masonry shall be solid units.

b. Chimneys and masonry fireplaces shall be supported on concrete or other masonry. Chimney shall not support loads other than their own weight unless they are designed and constructed to support the additional load.

c. Provide a thimble for all masonry chimneys except fireplace chimneys. A clean out door at the bottom of chimney shall be installed in chimneys serving solid fuel burning equipment.

d. Provide a chimney cap of concrete or other waterproof noncombustible material. Chimney cap shall be sloped from flue to outside edge. Min. thickness of concrete cap at outside edge is 2 in.

e. Mortar for flue lining shall be type M or S or be fire clay mortar.

f. A chimney separation greater than ½ in. in any 10 foot measurement, from the main structure is unacceptable.

604–6.3 *Clearances from Combustible Material.*

Masonry chimney walls shall be separated from combustible construction as follows:

a. Framing members, 2 in. airspace. Airspace shall be firestopped at each floor level with strips of asbestos board or other noncombustible material.

b. Subfloor, flooring and roof sheathing, ¾ in. airspace.

c. Furring strips not wider than 1½ in. may be installed with zero clearances at corners of chimney.

d. Piers built integrally with chimney for support of wood beams or girders may be used provided wood is separated from chimney masonry with at least a 2 in. airspace.

604–6.4 *Chimney Termination Height.*

a. Masonry chimneys shall extend at least 2 ft above any part of a roof ridge or roof or parapet wall within 10 ft of the chimney.

b. Except as provided in 615, no chimney shall terminate less than 4 ft in vertical height above the highest barometric damper or draft hood on connected appliances.

604–6.5 *Chimney Connectors.*

a. Metal. Chimney connectors (smokepipes) for appliances using solid or liquid fuel, and vent connectors for gas-fired incinerators, or gas appliances without draft hood, shall be constructed of material having a resistance to corrosion and heat not less than that of No. 24 galv sheet steel.

b. Masonry. Masonry connectors or breeching shall be made of refractory material equivalent in resistance to heat and corrosion to high duty fire brick (ASTM C–106 Type A) not less than 3½ in. thick.

c. Chimney connector (smokepipe) shall have a max. length from appliance outlet to chimney of 75 percent of the vertical height of the chimney, unless part of an engineered venting system.

604–6.6 *Chimney Flue Area.*

a. The flue area for an appliance using solid or liquid fuel shall be as recommended by the appliance manufacturer or as determined by data in the ASHRAE Guide.

b. The area of a chimney into which two or more appliances are connected shall be not less than the area of the largest chimney connector plus 50 percent of the area of all other appliance connectors.

c. Area of flue serving fireplace shall be not less than the following:

(1) 1/10 of area of fireplace opening for chimneys 15 ft in height or over.

(2) ⅛ of area of fireplace opening for chimneys under 15 ft in height.

(3) Corner fireplaces or fireplaces open on two or more sides are considered special and shall be designed for each specific installation.

(4) Height of chimney is measured from fireplace throat to top of chimney.

604–6.7 *Flue Linings.*

a. Fire-clay flue lining, not less than ⅝ in. thick or other equally durable and heat resistant material shall be in all masonry chimneys except that flue lining may be omitted in fireplace chimneys only, when chimney walls are at least 8 in. (nominal) in thickness.

b. Flue linings shall be supported on masonry or concrete and shall extend from a point at least 8 in. below the flue connector to top of chimney; or for fireplaces, from top of throat to top of chimney.

c. Where two flues adjoin each other in same chimney, stagger joints at least 7 in. or install wythe.

d. Where more than two flues are located in same chimney, install 4 in. wythe bonded into chimney separating flues into groups of one or two.

e. Where diagonal offsets are necessary, bevel edges of flue liner at change in direction to insure smooth, tight joints.

f. Flue lining shall resist without cracking or softening a temperature of 1800 F.

604–6.8 *Chimney Reinforcing and Anchorage.*

Where earthquake design is required, masonry chimney shall be reinforced and anchored to frame as follows:

a. Vertical Bars.

Chimney area (sq in.)	No. of Bars	Size of Bars
Less than 300	4	No. 3
300 or over	4	No. 4

b. Horizontal Bars.

(1) No. 2 bars, 24 in. oc embedded in mortar joints, and

(2) No. 3 bars at chimney cap and each plane of anchorage.

c. Anchorage

(1) Anchor chimneys which are entirely or partly outside of exterior walls to structures at each floor line 6 ft or more above grade and at the upper ceiling or roof line.

(2) Anchorages shall consist of ¼ in. steel straps or equivalent reinforcing bars anchored to chimney masonry and to structural members of framework.

604–7 Masonry Fireplaces.

604–7.1 *General.*

a. Fireplace construction shall be safe, durable and suitable for its intended use. All site-built fireplaces, solid fuel or gas burning, shall be provided with a source of combustion air from outside the conditioned atmosphere of the house, directed (1) into the combustion chamber proper, or (2) into the room and along the same wall close to the fireplace. The combustion air supply duct shall be sized for the flow of air needed by the fireplace and shall be not smaller than the smoke pipe or the flue pipe.

b. Fireplaces and chimneys which do not draw properly because of faulty design or construction are not acceptable.

604–7.2 *Construction.*

a. Fireplaces shall be supported on concrete or other masonry. Concrete masonry shall be solid units.

b. Install damper in accordance with manufacturer's recommendations. Damper shall be of type which will effectively close the flue passage.

c. Parge smoke chamber with fire-clay mortar (refractory mortar) on all sides. Parging may be omitted if wall thickness is 8 in. Masonry mortar shall not be used for parging.

d. Hearth, including inner and outer hearth shall be fire brick, brick, concrete, stone, tile or other non-combustible heat-resistant material.

e. Outer hearth shall extend at least 16 in. in front of opening and at least 8 in. beyond each side of fireplace opening. A separate outer hearth is not required when floor construction and finish flooring are of non-combustible materials.

f. Where a lining of fire brick at least 2 in. thick is provided, the total thickness of firebox wall including lining shall be not less than 8 in. Where fire brick lining is not provided, thickness shall be not less than 12 in. Steel fireplace lining at least ¼ in. thick may be used in lieu of fire brick lining. Installation shall be in accordance with manufacturer's recommendations.

g. Separate flues shall be installed for each fireplace.

h. Masonry over a fireplace opening shall be supported by a lintel of noncombustible material.

604–7.3 *Clearances from Combustible Construction.*

a. Fireplace walls shall be separated from combustible construction as follows:

(1) Framing members, 2 in. airspace. Airspace shall be firestopped at floor level with extension of ceiling finish, strips of asbestos board or other noncombustible material.

(2) Subfloor and flooring ¾ in. airspace.

b. Piers built integrally with fireplace to support wood construction may be used provided wood is separated from fireplace masonry with at least 2 in. airspace.

c. Combustible material shall not be placed within 3½ in. of the edges of a fireplace opening. Combustible material above and projecting more than 1½ in. in front of fireplace opening shall be placed at least 12 in. above opening.

605 Metals.

605–1 General.

Metals construction shall assure safe and adequate support of all design loads, and shall be corrosion resistant to the degree required by exposure conditions.

605–2 Structural Steel.

605–2.1 *General.*

a. The design, fabrication, and erection of structural steel for buildings shall conform to AISC Specification for the Design, Fabrication and erection of Structural Steel for Buildings.

b. The design of cold-formed steel structural members shall conform to AISI Specification for the Design of Cold-Formed Steel Structural Members.

c. The design of light ga cold-formed stainless steel structural members shall conform to AISI Specification for the Design of Light Gauge Cold-Formed Stainless Steel Structural Members.

d. The design, fabrication and erection of open web steel joists shall conform to the following specifications adopted by the Steel Joist Institute and AISC: Standard Specifications for Open Web Steel Joists, J and H Series; Standard Specifications for Long Span Steel Joists, LJ and LH Series; and Standard Specifications for Deep, Long Span Steel Joists, DLJ and DLH Series.

605–2.2 *Lintels, Beams and Girders.*

Bearing on walls shall be that required to distribute load but not less than 4 in. Bearing plates, at least ¼ in. thick, shall be installed where beams or girders rest on masonry. Bed in protland cement mortar. Bearing plate may be omitted under wide flange beams.

Connections shall be riveted, bolted or welded.

605–2.3 *Columns.*

Columns supporting wood beams or girders shall have suitable column cap installed. Columns supporting steel beams or girders may be welded, bolted or riveted to beam or have column cap. Column cap shall be anchored to beam. Column base of steel or cast iron shall be installed. Base shall be anchored by bolts or be embedded in concrete at least 2 in.

605–2.4 *Tubular Steel columns.*

Light ga tubular steel columns shall be designed in accordance with the appropriate specification listed in 605–2.1. Adjustable length components of columns shall be installed in the same manner as conventional columns, and securely fastened at the top and bottom in such manner as to form a continuous unit capable of developing the strength of the main column section. The adjustable feature is to serve for purposes of adjusting the length only and shall not be used for jacking purposes. Columns shall be at least 3 in. in outside diameter with wall thickness of 0.120 in. or equivalent and shall be of a size adequate to support the design loads when designed in accordance with 605–2.1.

605–2.5 *Corrosion Protection.*

All structural steel shall be given a shop coat of rust-inhibitive paint and field coat of protective paint, or equivalent, except for steel encased in concrete or concealed by interior finish materials, stainless steel, corrosion resistant steel, or steel treated with coatings to provide corrosion resistance. All surfaces (inside and outside) of tubular steel columns shall be protected.

605–3 Aluminum.

Design and construction of structural aluminum shall be in accordance with the Specifications for Aluminum Structures and Aluminum Formed-Sheet Building Sheating Guide by AA.

605–4 Welding.

Welding shall be in accordance with D1–1, Structural Welding Code and D12.1, Reinforcing Steel Welding Code, by AWS.

605–5 Metal Curtain Walls.

605–5.1 *Panels.*

Panels shall be capable of carrying the design load and deflections without suffering damage as permanent deformation.

Surfaces exposed as finish shall be protected against damage from scratches, stains, discolorations, or other causes. Marred metal or glass shall be refinished or replaced.

605–5.2 *Joints.*

Thermal movements caused by an ambient temperature range of 120 F shall be compensated for in design and fabrication of joints that will permit expansion and contraction of component material. In areas having an outdoor design temperature of 0 F or colder, install thermal breaks for through metal elements in panel jointing.

Joints in exposed work shall be carefully matched to produce continuity of line an design.

605–5.3 *Fasteners.*

Metals used for fasteners and anchorage devices shall be chemically compatible with contiguous metals.

606 *Carpentry.*

606–1 General.

606–1.1 *General.*

a. Wood construction shall be such as to assure safe and adequate support of all design loads and to provide a suitable base for the attachment of finish materials.

b. Wood products, except under special design conditions concerning material treated for use below grade, shallb be at least 8 in. above adjacent finish grade for framing members and 6 in. above finish grade for siding.

c. Bows in interior and exterior walls shall be too slight to detract from the walls' finished surface. Walls shall not be more than ½ in. out of plumb for any 8 ft. vertical measurement nor more than ¼ in. out of plumb within any 32 in. horizontal or vertical measurement.

606–1.2 *Fasteners.*

Application and fastening schedule of all fasteners, power, mechanically or manually driven shall conform to Appendix F unless otherwise shown in this MPS.

606–2 Termite Protection.

606–2.1 Provide protection against termites in those areas where they are determined to be a hazard. Methods of protection are divided into two types, chemical and physical barriers. With the exception of treated lumber, all barriers shown are effective only for subterranean termites. Where dampwood, drywood and Formosan termites present a hazard, additional precautions shall be required by the HUD field office.

606–2.2 *Physical Barriers.*

Acceptable physical barriers are as follows:

a. Concrete foundations, free of cracks and porous areas, for basement and crawl space types of construction except where masonry or masonry veneer walls extend below top of foundation wall and are less than 8 in. above finish grade.

b. Monolithic framed concerete slab, reinforced with at least 6 x 6 10/10 wwf in areas where winter design temperature exceeds 15 F, extending from wall to wall without openings or joints. Piping, ductwork and other penetration of slab shall be thoroughly sealed with coal tar pitch. Interior and exterior sill plates in contact with the concrete slab shall be treated wood in accordance with 506–2.4 or shall be Foundation Grade Redwood.

c. Foundation caps of cast-in-place concrete, not less than 4 in. thick, reinforced with 2 No. 3 bars.

606–2.3 Chemical barriers may be soil treatment referenced in 602 or pressure treated lumber.

606–3 Decay Protection.

606–3.1 *Protection Against Damage by Decay.*

Provide protection against damage by decay where required by the HUD field office. Certain members are required to be protected in all geographic areas. These members and the accepted means of protection are shown in Table 6–6.1.

606–3.2 *Requirement for Treatment of Other Members.*

The requirement for treatment of other members shall be based upon the location of wood members in respect to moisture conditions and upon climatic considerations such as annual precipitation, relative humidity and temperature during periods of high humidity.

TABLE 6–6.1—DECAY PROTECTION

Wood Members to be Treated	Means of Protection (2)	Resistant Species 506–2.4c	Non-Pressure Treatment 506–2.4b	Pressure-Treatment 506–2.4a
Access panels, doors and frames to basementless spaces (1)		X	X	X
Exposed structural members unless protected from direct exposure to rain by overhangs, porch ceilings or carport ceilings (1)		X	—	X
Exterior door and window frames, panel and jalousie doors (1)		—	X	X
Exterior window sash (1)		—	X	—
Exterior wood balconies (1)		X	—	X
Fence and privacy screen posts or columns		X	—	X
Sills, plates or sleepers embedded in concrete slabs concrete slabs		X	—	X

Notes:

(1) Treatment shall be paintable type.

(2) When treated material is cut after treatment, dip or brush-treat exposed ends in 5 percent pentachlorophenol solution or other acceptable wood preservative.

606–4 Framing.

606–4.1 *General.*

a. Wood framing shall provide construction which will assure safe support of all design loads and provide a suitable base for the attachment of sheathing or finish materials.

b. Framing design shall be in accordance with NFPA National Design Specifications for Wood Construction. NFPA Span Tables for Joists and Rafters may be used to determine allowable spans for wood framing when such spans are not determined by structural analysis.

c. Framing shall be designed to support all design loads without exceeding the allowable stresses and deflections. Span and spacing of framing members shall be determined by design except where application of sheathing, subfloor, or finish material requires a lesser spacing.

d. Vertical framing members shall be continuous lengths for each story height without splicing. Splices in horizontal members other than top member of two-member plates shall occur only over bearing points.

e. Structural members whose strength is impaired by improper cutting, drilling, or excessive defects shall be replaced or reinforced in a manner acceptable to the HUD field office.

606–4.2 *Wood Columns*

a. Columns shall bear on concrete or solid masonry bases. In basements, porches, garages and carports, top of base shall be not less than 3 in. above the finish floor. In basementless spaces, top of base shall be not less than 8 in. above inside grade.

b. Exterior columns shall be anchored to pier or base, and roof construction shall be anchored to columns. Columns in basement shall be anchored to girder and doweled or anchored to base. Where earthquake design is required, columns shall be anchored to the base and top of column shall be anchored to girder by bracing in both directions or by other suitable means acceptable to the HUD field office.

606–4.3 *Sills and Plates*

a. These standards apply to sill plates and to rafter and joist plates for masonry wall construction. Frame wall and partition plates or continuous headers are covered under Wall and Partition Framing, 606–4.7.

b. Width of plates shall be such as to provide for full end bearing of studs and not less than 1½ in. bearing for ends of joists and rafters. Rafter plates bearing on uncapped masonry walls shall bear on both faces of the unit masonry.

c. Sills and plates shall be anchored to foundations or walls in such a manner as to resist all wind loads and earth pressure. Except in cases where earthquake design is required, or where concrete slab construction is used, anchors may be omitted when a structural analysis of wind and earth pressure indicates anchorage is not required.

606–4.4 *Wood Floors, Girders and Beams*

a. End bearing for joists and girders shall be such that the allowable bearing stress of the species used is not exceeded and shall be not less than:

(1) Girders, 4 in. Wood shims not acceptable.

(2) Joists, framed into masonry, 3 in.

(3) Joists framed into sides of beams, or onto sill plate or foundation, 1½ in.

b. Joists framed into side of steel beam shall bear on lower flange of beam or on a ledger, bolted to beam. Block between joist if flange bearing is used. Unless lateral tie is provided by subfloor, tie every third joist to opposite joist with a 1½ in. x 18 in. ga steel strap. Where joist frame into only one side of steel beam, prevention of rotation of steel beam shall be assured.

c. Joists and girders framing into masonry walls shall bear on solid masonry not less than 4 in. thick. Provide ½ in. air space at ends and sides of wood girders and joists framing into concrete or masonry walls unless treated wood is used. Joists 5 ft or more above grade shall be anchored to masonry walls by metal anchors, at intervals of not more than 6 ft oc.

d. Joists framed on exterior sill plate or foundation wall shall be anchored in such a manner as to resist all wind loads and earth pressure. Also provide end block or header joist (band joist) to prevent lateral movement and to provide for subfloor nailing when required.

e. Joists shall be doubled under all parallel partitions except when single joist is of sufficient size to adequately support partition load in addition to contributory floor load.

f. Single headers may be used for a max. span of 4 ft, and double headers for a max. span of 10 ft. Header supporting load of bearing partition or concentrated load of kitchen equipment shall be designed as a beam. Single trimmer may be used to support load of single header when opening is near end of joist span. All other trimmers shall be at least doubled. Unless concentrated load from header is supported by column, size and span of trimmer shall be designed to support load from header.

g. Bridging, max. spacing of 10 ft, shall be installed between joists when nominal depth of joists is more than 6 times the nominal width.

606–4.5 *Ceiling Framing*

a. Where stair is provided to attic space, or where space will permit development of future rooms, framing shall comply with requirements for floor framing. Where unusual loading conditions occur such as mechanical equipment located in attic space, provide additional framing as necessary.

b. Ends of ceiling joists shall be lapped or butted over bearing partition or beam and toenailed to bearing. When ceiling joists are used to provide resistance to rafter thrust, lapped joists shall be nailed together, and butted joists shall be tied together in a manner to resist such thrust.

c. Where earthquake design is required, provide diagonal sway bracing over large living areas or other locations where resistance to horizontal forces is not providing for by partitions or roof diaphragm.

606–4.6 *Roof Framing*

a. Rafters shall be cut for even bearing and toenailed to plate. In areas subject to wind uplift forces of 25 psf or greater provide additional anchorage by installing a metal strap nailed to rafter or ceiling joist and to wall stud, or use special anchors designed for this purpose.

b. Rafters and ceiling joists shall be nailed together and to exterior wall plate to resist roof thrust. Where rafters frame in a different direction than ceiling joists, rafters shall be supported at ridge with beam or partition, or shall have other provisions to resist roof thrust. Roof joists for slopes less than 3 in 12 shall be supported at ridge by beam, partition or other suitable means.

c. Ridge board, if used, shall be not less in depth than end cut of rafter.

d. Provide rafter ties, spaced not more than 48 in. oc, in the upper third of attic space. Where tie serves as ceiling joists in 1½ story construction, comply with ceiling framing standards.

e. Hip and valley rafters shall be supported at the ridge by a brace to a bearing partition.

f. Trussed roof framing shall comply with 4950.2, Design Criteria for Trussed Rafters.

606–4.7 *Wall and Partition Framing*

a. Exterior walls shall be anchored to floor framing or sill plate in a manner to resist all uplift, sliding, and overturning loads.

b. Exterior wall construction shall provide resistance to racking by means of diagonal wood sheathing; nominal 4 in. wide corner braces let into face of sole plate, studs, and top plate when used with other sheathing; or by braced wall sections of other material complying with tests and criteria stated in Appendix D.

c. Where earthquake design is required, provide effective bracing in both directions, in each 25 ft of wall, and in principal partitions. Interior bracing may be omitted when roof sheathing qualifies as a diaphragm.

d. Where line wire is used for exterior stucco backing, studs in unsheathed walls shall be blocked at mid-height. Line wire backing without sheathing may be used for one story construction and for 2-story construction in areas not subject to wind loads in excess of 20 psf. In areas subject to earthquake design 2-story construction of this type is permitted only when the structural frame is designed and constructed to withstand the required lateral forces assumed to act nonconcurrently in the direction of each main axis of the structure.

e. Header shall be supported by jamb studs and be designed to support load imposed.

f. Wood posts supporting beams or lintels, as in post and beam framing, shall be designed as columns, and intermediate studs or blocking shall be provided between posts as required for support of interior and exterior covering material.

g. Bearing and exterior wall studs shall be capped with double top plates installed to provide overlapping at corners and at intersections with other partitions. End joints in double top plates shall be offset at least 48 in.

Exception: A single top plate may be installed in bearing and exterior walls provided the plate is adequately tied at joints, corners and intersecting walls by at least the equivalent of 3-inch by 6-inch by 0.036-inch thick galvanized steel that is nailed to each wall or segment of wall by three 8d nails or equivalent, provided the rafters or joists are centered over the studs with a tolerance of no more than 2 inches. Top plates may be omitted over lintels which are adequately tied to adjacent wall sections as previously described or with 1-inch by 4-inch by 12-inch wood members splice nailed to each wall section by three 8d nails or equivalent.

h. A continuous header sized according to the span of the largest opening may be used in lieu of a double top plate. Header members shall be connected at corners and at intersecting bearing partitions with sheet metal corner ties, lag screws or other suitable means.

i. Corners of rooms shall be blocked or framed to receive interior finish.

606–4.8 *Stair Framing*

a. Stringers shall have a min. effective depth of at least 3½ in., and shall have solid bearing at top and bottom. The max. distance between stringers is 30 in. for nominal ¾ in. treads, and 36 in. for nominal 2 in. treads.

b. Factory built stairs having wedged and glued treads and risers may be supported by two stringers when width of stair does not exceed 42 in.

606–5 *Subfloor and Sheathing*

606–5.1 *General*

a. Provide safe support of loads without excessive deflection and provide backing and support for the attachment of finish materials.

b. When roof deck is also finished ceiling surface, a vapor barrier with a permeance of not more than ½ perm shall be installed between deck and roof insulation in areas where the design temperature is 10°F or lower.

c. Application of materials by staples, shall comply with Use of Materials Bulletin No. UM–25.

606–5.2 *Wood Boards and Planks*

Maximum spacing of supports shall comply with Table 6–6–2.

TABLE 6-6.2—MAXIMUM SPACING OF SUPPORT (Inches)

Material	Subfloor	Wall Sheathing	Roof Sheathing
1 in. board - solid	16(1)	24	24
(3/4 in. net) spaced	NA	16(2)	16(2)
3/4 in. board - solid	16(1)	24	24(3)
(5/8 in. net) spaced	NA	16(2)	16(2)&(3)

Notes:

(1) 24 in., when applied diagonally and wood strip flooring is applied perpendicular to joists.

(2) May be 24 in. if board is 4 in. or wider.

(3) Roof slopes of 3 in. to 12 in. and over.

606-5.3 *Plywood*

a. Max. spacing of supports, are shown in Table 6-6.3 for subfloor and sheathing.

b. Where resilient flooring, wood block, carpeting, or ceramic tile is to be applied to subfloor without separate underlayment, a combination subfloor-underlayment grade of plywood shall be used. Thickness, span and installation shall comply with the finish flooring manufacturer's instructions, but not less than the min. thickness and max. joist spacing shown in Table 6-6.4 shall be used.

TABLE 6-6-3—PLYWOOD SUBFLOOR AND SHEATHING

Panel Identification	Thickness (in.)	Maximum Spacing of Supports (in.)					
		Subfloor and roof used as walking surface(1)	Wall Sheathing		Roof Sheathing(1)		
			Exterior finish nailed to		Asphalt, Wood Shingles & Shakes, Built-up roofs		20 year Bonded Roofs
			Studs	Sheathing	Edges(2)		Edges(2)
					Blocked	Unblocked	Blocked
12/0	5/16	NA	16	16(3)	12	12	NA
16/0	5/16	NA	16	16(3)	16	16	NA
	3/8		24	16(5)	16	16	
20/0	5/16	NA	16	16(3)	20	20	NA
	3/8		24	16(5)	20	20	
24/0	3/8	NA	24	16(5)	24	20	16
	1/2		24	24	24	24	16
30/12	5/8	12	24	24	30	26	24
32/16	1/2	16(4)	24	24	32	28	24
	5/8	16(4)	24	24	32	28	24
36/16	3/4	16(4)	—	—	30	30	24
42/40	5/8						
	3/4	20(4)	—	—	42	32	32
	7/8						
48/24	3/4	24			48	36	48
	7/8	24	—	—	48	36	48
Groups 1 & 2	1 1/8	48	—	—	72	48	72
Groups 3 & 4	1 1/4	48	—	—	72	48	72

— = Not applicable NA = Not acceptable

Notes:

(1) Applicable to C-D, Structural I and II, and C-C Exterior grades only.

(2) Blocking of unsupported edges of roof sheathing shall be by means of wood blocking, approved T and G edges or special corrosion resistant metal H clips designed for this purpose. Use one clip for each space less than 48 in. in width, and two clips for spaces 48 in. and wider.

(3) Apply grain of face ply perpendicular to studs.

(4) May be 24 in. if 25/32 wood strip flooring is applied perpendicular to joists.

(5) May be 24 in. if face grain is perpendicular to stud.

TABLE 6-6.4—PLYWOOD COMBINATION SUBFLOOR-UNDERLAYMENT (1)(3)
(Plywood continuous over two or more spans)

Species Groups	Maximum Spacing of Joists (in.) (2)		
	16	20	24
	Plywood Thickness (in.)		
1	1/2	5/8	3/4
2, 3	5/8	3/4	7/8
4	3/4	7/8	1

Notes

(1) Applicable to C–C Plugged, Underlayment with Intermediate or Exterior Glues and Underlayment grades of plywood. For T & G laminated wood block flooring, laid with ½ bond pattern, sheathing grades of plywood may be used.

(2) Plywood with approved T & G edges shall be used or solid blocking shall be installed under all unsupported edges.

(3) Leave $\frac{1}{16}$ in. spacing between joints. Set nails $\frac{1}{16}$ in. and lightly sand subfloor at joints if resilient flooring is to be applied.

606–5.4 *Fiberboard and Gypsum Sheathing*

Application shall comply with the procedures directions and with Table 6–6.5.

606–5.5 *Sheathing Paper*

a. Sheathing paper shall be installed over sheathing, or where omission of sheathing is permitted over wall framing, under all exterior wall finish materials with the following exceptions:

(1) Detached garages and garages separated from dwelling by porch or covered entrance platform.

(2) Panel siding with shiplap joints or battens.

(3) Other wall finish materials, except stucco finish, over plywood, fiberboard or treated gypsum board sheathing.

(4) Paper-backed stucco lath may be considered sheathing paper where method of attachment does not puncture paper.

b. Install strips of sheathing paper, at least 6 in. wide, behind all exterior trim unless a weather tight joint can be otherwise assured.

606–6 Finish Carpentry

Construction and installation shall be acceptable to the HUD field office.

606–7 Heavy Timber and Glue-Laminated Timber

Heavy timber and glue-laminated timber construction shall conform to the applicable sections of the AITC Timber Construction Manual.

606–8 Custom Woodwork

Custom woodwork shall meet the requirements of similar noncustom work and shall be acceptable to the HUD field office.

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TABLE 6-6.5---GYPSUM SHEATHING, FIBERBOARD SHEATHING AND FIBERBOARD ROOF DECK

Material	Gypsum Sheathing (2)			Fiberboard Roof Deck (1)	
Size	1/2 in. x 2 ft x 8 ft	1/2 in. x 4 ft x 8 ft (or longer)		2 in.	3 in.
Corner Bracing(3)	Installed	Installed	Omitted	NA	NA
Max. Framing Spacing	24 in.	24 in.	16 in.	32 in.	48 in.
Nail Size(4)	1 1/2 in. x 11 ga.	1 1/2 in. x 11 ga.	1 1/2 in. x 11 ga.	Adequate to penetrate 1 1/2 in. into framing	
Nail Pattern: Edge Intermediate	8 in. 8 in.	8 in. 8 in.	4 in. 8 in.	4 1/2 in. at main supports 8 in. at ridge and openings	
Installation	Horizontal	Horizontal or Vertical	Vertical	Long dimension perpendicular to framing. Stagger end joints.	

Material	Fiberboard Sheathing (2)							
Size	1/2 in. x 2 ft x 8 ft		1/2 in. x 4 ft x 8 ft		25/32 in. x 2 ft x 8 ft		25/32 in. x 4 ft x 8 ft	
Corner Bracing(3)	Installed	Omitted	Installed	Omitted	Installed	Omitted	Installed	Omitted
Max. Framing Spacing	16 in.	NA	24 in.	16 in.	16 in.	NA	24 in.	16 in.
Nail Size(4)	1 1/2 in. Roofing nail or 6d Common nail				1 3/4 in. Roofing nail or 8d Common nail			
Nail Pattern: Edge Intermediate	Approx. 4 1/2 in. oc	NA	4 in. 8 in.	3 in. 4 in.	Approx. 4 1/2 in. oc	NA	4 in. 8 in.	3 in. 6 in.
Installation	Horizontal	NA	Vertical	Vertical	Horizontal	NA	Vertical	Vertical

Abbreviation: NA = Not applicable.

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Notes:

(1) Structural fiberboard insulating roof deck, without vapor barrier, used as combined roof deck and ceiling finish shall be limited to areas where the outside design temperature is more then 10° F.

(2) Sheathing unless identified as Nail Base, shall not be used as a nailing base. Shingle type exterior finish materials may be supported by nail base sheathing when special methods of attachment designed for this use are used.

(3) Omission of corner bracing is dependent upon compliance with criteria for resistance to racking as shown in Appendix D.

(4) Application by staples shall conform to UM 25. See Appendix F.

607 *Thermal and Moisture Protection*

607–1 General

Construction shall provide: adequate resistance to the penetration of weather and moisture, reasonable durability and economy of maintenance.

607–2 Waterproofing, Dampproofing and Vapor Retarders

607–2.1 *Waterproofing*

Basement and habitable areas below grade shall be designed and constructed so as to be protected at all points against penetration of water.

a. Membrane Waterproofing for Slabs-On-Ground. Where bottom of slabs-on-ground in habitable areas are at or below outside finish grade, install a waterproof membrane under the slab. Membrane material shall provide at least the equivalent protection of 2 ply hotmopped felts, 6 mil polyethylene, or 55 lb roll roofing. All laps shall be sealed.

b. Foundation Waterproofing. Where habitable areas are provided below grade, foundation walls shall be waterproofed by a waterproof membrane extending from edge of footing up to finish grade line. All laps shall be sealed. Membrane shall be firmly affixed to wall. Membrane material shall provide at least the equivalent protection of 2 ply hotmopped felts, 6 mil polyvinyl chloride, or 55 lb roll roofing.

c. Alternate Waterproof Membranes. Alternate membranes shall be tested in accordance with ASTM E154. They shall be of one piece construction or have a practical field jointing system which assures a waterproof joint.

d. Hydrostatic Pressure. Where hydrostatic pressure occurs, slabs-on-ground and exterior surfaces of walls below ground level shall be waterproofed. Waterproofing shall be designed and applied in accordance with accepted engineering practice.

607–2.2 *Dampproofing*

Where waterproofing is not required, install dampproofing to protect spaces below grade against the penetration of moisture.

a. Dampproofing of Slabs. Treatment material having a vapor transmission rate not exceeding ½ perm shall be installed as required by 603–4.4.

b. Dampproofing Walls. Where no habitable areas are provided below grade, foundation walls shall be dampproofed as follows:

(1) Masonry foundation walls. Treatment materials shall provide at least the equivalent protection of 1 coat of portland cement, ⅜ in. thick plus 1 coat of bituminous dampproofing material complying with Appendix C.

(2) Concrete foundation walls. Treatment materials shall provide at least the equivalent protection of 1 coat of bituminous dampproofing material applied at the rate recommended by the material manufacturer. Bituminous material shall comply with Appendix C.

607–2.3 *Foundation Drainage*

Foundation or footing drainage shall be provided around foundations enclosing basements or habitable areas below grade. Drains shall be installed at or below the area to be protected and shall discharge by gravity or by mechanical means to a positive outfall such as a drainage ditch or swale, or into a storm system.

607–2.4 *Vapor Retarders*

a. Walls. A vapor retarder having a vapor transmission rate not exceeding 1 perm shall be installed on the warm side (winter) of the insulated walls. The materials of the wall on the cold side of the vapor barrier, such as insulation, sheathing, exterior finish or combination of materials shall have a vapor transmission rate (perm rating) of more than the interior vapor retarder, or have provision for vapor venting to outside.

b. Ceilings. When a vapor retarder is provided in ceiling under a ventilated roof or attic space, transmission rate of vapor retarder shall not exceed 1 perm. Install on warm side of ceiling.

c. Roof Deck. When a concrete slab, steel deck, wood plank, or other roof deck material is also the finish ceiling surface or the space below is not ventilated, a vapor retarder having a vapor permeance of not more than ½ perm shall be installed near the warm side of the construction.

Joints at sides and ends of fiberboard roof deck shall be designed to provide effective sealing of vapor retarder.

d. Slabs-On-Ground. (See 507–2.2 and 603–4 for requirements).

e. Crawl Spaces. Ground surface treatment material having a vapor transmission rate not exceeding 1 perm shall be installed as required by 402–3 and 601–11.2b(4).

607–2.5 *Special Conditions*

a. In locations where the foundation is subjected to a high water table or where surface or ground water drainage may present a problem, additional precautions will be required.

b. Where the specific site conditions indicate that well drained soil exists or where ground surface water will not present a problem, lower standards may be permitted.

c. In dry regions with an average annual precipitation of less than 15 in., where no problems exist on the site under construction, lower standards for moisture protection may be permitted for slab floors and basement foundations.

607–3 Building Insulation

607–3.1 *General*

Insulation of buildings shall be such as to assure conservation of energy, economy of operation and comfort to the occupants.

607–3.2 *Overall Coefficient of Heat Transmission*

a. All buildings which are heated or cooled mechanically shall be constructed to comply with the U values shown in Table 6–7.1. U values shown do not include adjustments for framing in walls, ceilings or floors, nor for the sash frame in windows or glass doors.

b. Where the stated U value of any one component of roof deck, ceiling, wall or floor cannot be practically obtained, such U value may be increased to the min. figure attainable and the U value for other components decreased until the overall heat gain or heat loss does not exceed the total resulting from conformance to the stated U values.

607–3.3 *Component Coefficient Values*

For ceilings, walls, floors and openings, U values shall not exceed those shown in Table 6–7.1.

TABLE 6–7.1—Maximum U Values for Ceiling, Wall and Floor Sections for Electric Resistance Heat (E.R.) and Heat Pump or Fossil Fuel Heat (F.F.) (1)*

Heating Degree Days (65 F Base)	Ceilings (2)		Walls		Floors (3)		Windows (4)		Sliding Glass Doors (4)		Storm Units (5)	
	E.R.	F.F.	E.R.	F.F.	E.R.	F.F.	E.R.	F.F.	E.R.	F.F.	E.R.	F.F.
0 - 1000	.05	.05	.08	.08	—	—	1.13	1.13	1.13	1.13	No	No
1001 - 2500	.04	.05	.07	.08	—	—	.69	1.13	.69	1.13	No (6)	No
2501 - 3500	.03	.04	.05	.08	.07	—	.69	1.13	.69	1.13	No (6)	No
3501 - 4500	.03	.03	.05	.07	.05	.07	.69	.69	.69	.69	No (6)	No (6)
4501 - 6000	.03	.03	.05	.07	.05	.07	.47	.69	.69	.69	Yes	No (6)
6001 - 7000	.026	.03	.05	.07	.05	.07	.47	.69	.69	.69	Yes	No (6)
7001 +	.026	.026	.05	.05	.05	.05	.47	.47	.69	.69	Yes	Yes

* In conformance with a Congressional mandate this standard is being considered for revision. Any change will be announced in the Federal Register when adopted.

Notes:

(1) For areas of 5000 heating degree days (HDD) or less, houses using heat pumps may be insulated to levels required for fossel fuels. In areas above 5000 HDD, houses using air to air heat pumps with electric resistance supplemental heat shall be insulated to levels required for electric resistance (ER) heating.

(2) Includes roof/ceiling assemblies, in which the finished ceiling is the underside of the roof deck.

(3) For floors of heated spaces over unheated basements, unheated garages or unheated crawl spaces.

A basement, crawl space or garage shall be considered unheated unless it is provided with a positive heat supply to maintain a min. temperature of 50 F.

Postive heat supply is defined by ASHRAE as "heat supplied to a space by design or by heat losses occurring from energy-consuming systems or components associated with that space."

Where the walls of an unheated basement or crawl space are insulated in lieu of floor insulation, the total heat loss attributed to the floor from the heated area shall not exeed the heat loss calculated for floors with required insulation.

(4) Maximum glass area shall not exceed 15 percent of the gross area of all exterior walls enclosing heated spaces, except when demonstrated that the winter daily solar heat gain exceeds the 24 hour heat loss and the glass area is properly screened from summer solar heat gain. In areas where cooling is the predominant load and the heating load is insignificant (as an example, 2000 or more cooling hours and 2000 or less winter degree days), the maximum glazing area stated above may be waived when glass area is properly screened from solar heat gain. Any additional glass area shall have a significant portion of operable sash in order to provide natural ventilation.

(5) A 1¾ inch metal faced door system with an insulated core and durable weather-stripping providing a U value equal or better than 0.32, and an infiltration rate no greater than .50 cfm per foot of crack length, tested according to ASTM E–283 at 1.567 psf of air pressure, may be substituted for a conventional door and storm door. All exterior doors shall be weatherstripped.

(6) In areas with 1501 or more winter degree days, a storm door is required when the primary door is a hollow core door or is over 25% glass.

607–3.4 *Alternate Performance Criteria*

a. As an alternative to conformance with Table 6–7.1, dwellings which conform to the performance criteria of this section shall be considered acceptable.

b. U_o (gross wall)—Total exterior wall area (opaque wall and window and door) shall have a combined thermal transmittance value (U_o value) not to exceed the values shown in Figure 1. Equation 1 shall be used to determine acceptable combinations to meet the requirements of Figure 1.

Equation 1 Formula for Determining Combinations (See Figure 1) $U_o = ({}^{U}\text{wall}\ {}^{A}\text{wall} + {}^{U}\text{window}\ {}^{A}\text{window} + {}^{U}\text{door}\ {}^{A}\text{door}) / A_o$

Where:

U_o = the average thermal transmittance of the gross wall area, Btu/h x sq ft x F

A_o = the gross area of all exterior walls enclosing heated spaces, sq ft

${}^{U}\text{wall}$ = the thermall transmittance of all elements of the opaque wall area, Btu/h x sq ft x F

${}^{A}\text{wall}$ = opaque wall area enclosing heated spaces, sq ft

${}^{U}\text{window}$ = the thermal transmittance of the window area, Btu/h x sq ft x F

${}^{A}\text{window}$ = window area (including sash), sq ft.

${}^{U}\text{door}$ = the thermal transmittance of the door area, Btu/h x sq ft x F.

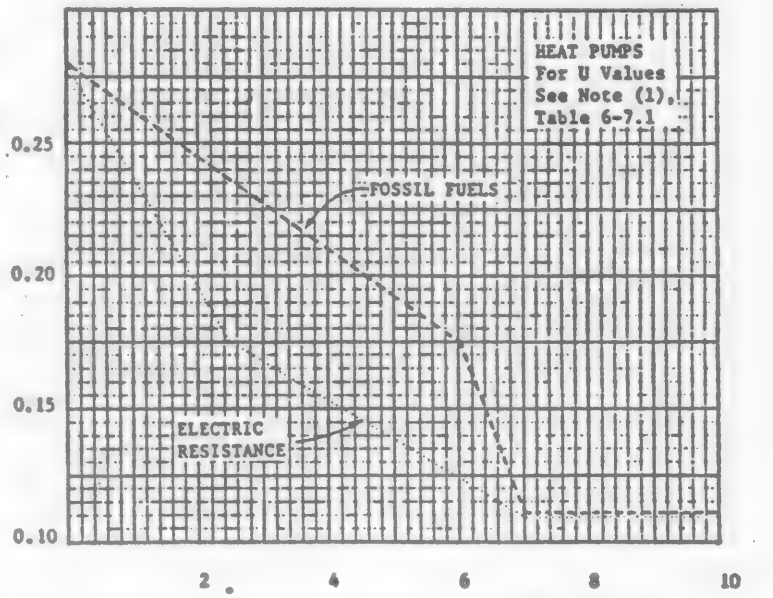
${}^{A}\text{door}$ = door area (including sash), sq ft.

Note.—Where more than one type of wall, window and/or door is used, the U x A term for that exposure shall be expanded into its sub-elements, as:

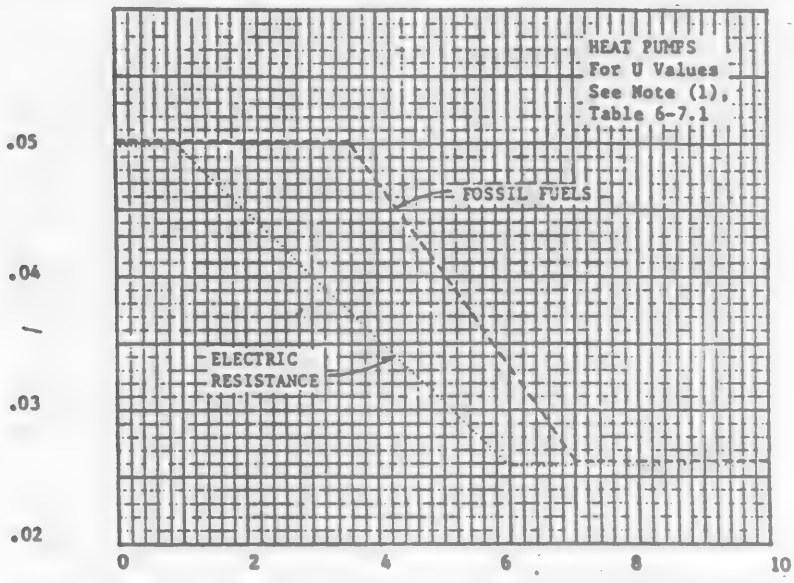
c. U. (gross ceiling)—Total ceiling area (opaque ceiling and skylights) shall have a combined thermal transmittance value (U. value) not to exceed the values shown in Figure 2. Equation 2 shall be used to determine acceptable combinations to meet the requirements of Figure 2.

${}^{U}\text{wall}_1\ {}^{A}\text{wall}_1 + {}^{U}\text{wall}_2\ {}^{A}\text{wall}_2$, etc.

FIGURE 1—GROSS WALLS



GROSS CEILING - FIGURE 2



Equation 2 Formula for Determining Roof/Ceiling Combinations

$U. = ({}^{U}roof {}^{A}roof + {}^{U}skylight {}^{A}skylight) / A.$

where:

U. = the average thermal transmittance of the gross roof/ceiling area, Btu/h x sq ft x F

A. = the gross area of a roof/ceiling assembly, sq ft

$^{A}roof$ = opaque roof/ceiling area, sq ft

$^{U}roof$ = the thermal transmittance of all elements of the opaque roof/ceiling area, Btu/h x sq ft x F

$^{U}skylight$ = the thermal transmittance of all skylight elements in the roof/ceiling assembly, Btu/h x sq ft x F

$^{A}skylight$ = skylight area (including frame), sq ft.

Note.—Where more than one type of roof/ceiling and/or skylight is used, the U x A term for that exposure shall be expanded into its sub-elements, as: $^{U}roof_1 {}^{A}roof_1 + {}^{U}roof_2 {}^{A}roof_2$, etc.

607-3.5 *Overall Structure Performance Alternative.*

Structures which can be shown by accepted engineering practice to have energy consumption equal to or less than that which would be obtained by conformance to the criteria of 607-3.3 or 607-3.4 shall be considered acceptable. The contribution of passive solar energy and the related storage and reradiation capacity of masonry, water and other mass may be recognized in computing energy consumption under this alternate method. The following requirements shall govern in determining comparability:

a. The methodology shall be cost effective to the energy consumer.

b. The methodology shall not adversely affect the structural capacity, durability, or safety aspects of the structure.

c. All data and calculating must show valid performance comparisons between the proposed option and a structure comparable in size, configuration, orientation and occupant usage designed in accordance with 607-3.3 or 607-3.4.

607-3.6 *Basement or Crawl Space Foundation Walls.*

Insulation may be omitted from floors over heated basement areas or heated crawl spaces if foundation walls are insulated. Foundation walls of heated areas below grade need not be insulated except where recreation or similar use rooms or habitable rooms are provided or where more than 50 percent of the wall is exposed to outside air. The U value of foundation wall sections shall not exceed the value shown in Table 6-7.2 except where the alternative methods shown in 607-3.4 or 607-3.5 are employed and foundation walls are included in the determination of the average thermal transmittance of the gross wall area.

TABLE 6-7.2—Maximum U Values of the Foundation Wall Sections of Heated Basement or Heated Crawl Space

Winter Degree Days (65 F Base)	Maximum U Value
2500 or less	No Requirement
2501 to 4500	0.17
4501 or more	0.10

607–3.7 *Crawl Space Plenum Walls.*

When a crawl space is used as a supply or return plenum, the crawl space perimeter wall shall be insulated to provide a max. heat loss of 35 Btuh per lineal ft of perimeter wall assuming a crawl space air termperature of 70 F for return plenums and 110 F for supply plenums.

607–3.8 *Slab-on-Grade Floors.*

For slab-on-grade floors of heated or mechanically cooled spaces, the thermal resistance of the insulation around the perimeter of the floor shall be not less than shown in Table 607.3. Insulation shall extend downward from the top of the slab for not less than 24 in. or downward to the bottom of the slab and horizontally beneath the slab for a min. total distance of 24 in.

TABLE 6-7.3—Minimum R Values of Perimeter Insulation for Slabs-on-Grade

Winter Degree Days (65 F Base)	Minimum R Values (1)	
	Heated Slab	Unheated Slab
500 or less	2.8	—
1000	3.5	—
2000	4.0	—
2500	4.4	2.5
3000	4.8	2.8
4000	5.5	3.5
5000	6.3	4.2
6000	7.0	4.8
7000	7.8	5.5
8000	8.5	6.2
9000	9.2	6.8
10000 or greater	10.0	7.5

Note.—(1) For increments between degree days shown, U values may be interpolated, or the values shown in Figure 2 of ASHRAE 90–75 may be substituted.

607–4 *Caulking.*

Joints and cracks in exterior wall surfaces and around openings shall be properly caulked to exclude the entry of water. Caulk, provide gasket(s) or otherwise seal around all openings in the exterior envelope of the conditioned atmosphere of the home, at all joints between dissimilar materials and at junctions of major components such as wall-to-floor, etc. Caulking shall be silicone rubber base or butyl rubber base, conforming to Federal Specifications TT–S–1543 and TT–S–1657 respectively, or materials demonstrating equivalent performance in resilience and durability.

607–5 Flashing.

607–5.1 *General.*

a. Flashing shall be provided to intercept or prevent water penetration of the exterior surface of a building element. Materials shall be selected on the basis of their suitability to the particular application for exposure, resistance to deterioration and differential thermal movement of horizontal and vertical building elements.

b. Flashing shall not leak under normally anticipated conditions.

c. Flashing shall have a service life at least equal to the assemblies into which it is built.

d. Alternate products or systems of bitumen-impregnated plastic or elastomeric materials may be used for flashing when they are installed in accordance with the manufacturer's recommendations and are acceptable to the HUD field office. Counter flashing is considered exposed flashing and shall be sheet metal.

e. Caulk between wood or metal and masonry at all openings with a non-hardening caulking compound.

607–5.2 *Head Flashing of Wall Openings.*

Install sheet metal flashing extending from front edge of trim or lintel, up and over trim or lintel and up 2 in. behind sheathing paper, or behind sheathing when sheathing paper is omitted. For cavity and multi-wythe masonry walls, flashing shall extend into the inner wythe.

607–5.3 Jamb Flashing.

For unsheathed wood frame walls, jambs shall be flashed with a 6 in. wide strip of metal, 3 oz copper-coated paper, 6 mil poly-ethylene or reinforced paper flashing complying with F.S. UU–B–790. Paper shall not be exposed to weather at any point. Jamb flashing may be omitted when wood panel siding not requiring sheathing is used.

607–5.4 *Sill Flashing.*

In masonry or masonry veneer walls, install sill flashing extending from front edge of masonry, under masonry sill, up to under side of window sill and under window sill to inside face of wall or into rabbet in underside of window sill. Sill flashing is not necessary when precast single piece sills are used.

607–5.5 *Other Wall Openings.*

a. Other openings or projections through exterior walls shall be made water tight.

b. Ventilators located in exterior walls shall be flashed in same manner as other openings unless self-flashing metal ventilators are used, or ventilator is installed directly under rake molding.

607–5.6 *Exterior Wall—Intersections of Different Materials.*

a. Install sheet metal flashing or concealed flashing at all horizontal and vertical intersections when exterior finish material does not provide a self-flashing joint.

b. All intersections of masonry with other materials shall be caulked.

607–5.7 *Roof Valleys.*

a. Rigid Shingle Roof Covering.

(1) Install sheet metal flashing as follows:

Roof slope	Minimum width
Under 4 inch 12	24 inch.
4 inch 12 to 7 inch 12	18 inch.
7 inch 12 and over	12 inch.

(2) Min. open valley width, 4 in. at top. Increase width at rate of ⅛ in. per ft. Closed valleys shall not be used on roofs with less than 10 in 12 slope.

b. Asphalt Shingle Roof Covering.

(1) Install sheet metal same as a. above, or

(2) Install two thicknesses of 85 lb mineral surfaced roll-roofing. Bottom strip shall be at least 18 in. wide; top strip, at least 36 in. wide.

(3) One thickness of 55 lb. smooth surface roll-roofing, 36 in. wide, may be used with closed or woven asphalt strip shingle valley treatment.

607–5.11 *Eave and Rake Flashing.*

a. For all shingle roofs having a slope of less than 4 in 12, install a metal drip edge along eaves and rake. Apply below underlay at eaves and over underlay at rake.

b. For gravel surfaced built-up roofing, install gravel stop at eaves and rake. In areas subject to winds in excess of 90 mph, joints in gravel stop shall be covered with a metal cover plate. Cover plate shall be precisely profiled to fit over gravel stop.

607–5.12 *Porch and Entrance Platform Slabs.*

Provide sheet metal flashing where concrete slabs abut wood construction. Sheet metal shall extend from inside face of foundation wall, across top of foundation wall under sill plate, and up at least 4 in. above top of slab.

607–5.13 *Parapet Flashing.*

Where wall coping is not an impervious material with watertight joints, through flashing shall be placed in mortar bed under coping. Flashing shall extend not less than ¼ in. on both sides of wall and be turned down to form a drip when copings are flush with wall surfaces. Where copings furnish an adequate drip, flashing may stop at wall surface.

607–5.14 *Spandrel Flashing.*

a. Provide continuous waterproofing at beams. Turn horizontal flashing 2 in. min. up on inner face of masonry wall. Two piece flashing may be used when pieces are lapped 4 in. min.

b. Reglets may be used to receive flashing.

c. Flash structural support for exterior masonry facing.

d. Where cavity walls are supported on concrete spandrel beams, flashing shall be placed on shelf angle and extend 8 in. up beam to corrosion-resistant reglet.

607–5.15 *Base Flashing.*

Base flashing shall be corrosion-resistant sheet metal, 30 lb asphalt-saturated felt or membrane type flashing. Install flashing to extend from outside of wall under outer course, up between courses at least 4 in. and embed in back-course. In single unit walls, extend under wall and up on inside at least 4 in. under furring.

c. Built-up Roof Covering.

Valley flashing is not required for built-up roofs when roof membrane does not require reinforcing.

607–5.8 *Roof to Wall Intersections.*

a. When shingles are used as roof covering, sheet metal flashing shall extend at least 3 in. under shingles and 4 in. up wall. Flashing installed in "step" fashion, providing a 3 in. headlap or one piece flashing may be used. One piece flashing shall not exceed 6 ft in length including overlaps.

b. In masonry walls, install counter-flashing at intersections. Embed top of counter-flashing 1 in. into masonry, extend down wall at least 6 in. lapping flashing a min. of 4 in.

c. When built-up roofing is used, flashing may be provided by mopping roofing directly onto wall provided cant strips and suitable counter-flashing are used.

607–5.9 *Roof to Chimney Intersections.*

a. On sloping roofs, a chimney saddle shall be installed at upper side of all chimneys 30 in. or more in width, when not intersecting ridge. Cover saddle with sheet metal or roofing. If sheet metal is used, extend at least 6 in. under shingles.

b. When shingles are used as roof covering, sheet metal flashing and counter-flashing shall be installed at the intersection as required in 607–5.8 a. and b.

c. When saddle is not installed, flashing on high side of chimney shall extend up at least 4 in. on chimney and extend under shingles to a point equal in height to flashing on chimney but not less than 1½ times shingles exposure. Counter-flash in accordance with 607–5.8b.

d. When built-up roofing is used, flashing may be provided as in 607–5.8c.

e. For chimneys and vents, other than masonry, install metal flashing to provide watertight joints.

607–5.10 *Pipe Projecting Through Roof.*

a. Flash with one piece sheet metal flashing, one piece neoprene gasket type flashing or two piece flange and sleeve flashing. Flange shall extend at least 6 in. on all sides but not less than 1½ times shingle exposure.

b. Counter-flash pipes or seal joints with mastic.

607–5.16 *Miscellaneous Flashing.*

Special flashing, such as at planter boxes, dormer windows, roof ventilators, etc. shall be provided. Details of flashing shall be acceptable to the HUD field office.

607–6 Gutters and Downspouts.

607–6.1 *Gutters.*

a. Gutters shall be provided when either of the following conditions are present:

(1) Soil is of such a nature that excessive erosion or expansion will occur or,

(2) Roof overhangs are less than 12 inches in width for one story or 24 inches in width for two story.

b. When gutters are omitted, a diverter or other suitable means shall be provided to prevent water from roofs or valleys from draining on uncovered entrance platforms or steps.

c. *Minimum size.* Gutters shall be sized as determined by the downspouts and their spacing. Use a gutter having approximately same area as downspouts for spacings up to 40 feet between downspouts. Increase width by 1 inch for each additional 20 feet of gutter.

d. *Basket strainers.* Install strainers at head of downspout when downspout is connected to an underground drain.

e. *Built-in gutters.* Details of built-in gutters shall be acceptable to HUD field office.

607–6.2 *Scuppers.*

a. Install at outfall end of valley for special roof designs such as "butterfly" roofs.

b. Install for overflow of all roofs enclosed by parapet walls except when construction of roof and type of roof covering are designed to hold water. Suitable overflow devices shall be used.

607–6.3 *Downspouts.*

Minimum size. Downspouts shall be sized on the basis of approximately 100 square feet of roof surface to 1 square inch of leader. More or less leader area may be required or permitted by the HUD field office to recognize differences in rainfall characteristics in particular areas.

608 *Doors, Windows and Glazing*

608–1 Door performance—General.

a. Doors shall be durable and installed in good operating condition, free of defects, latching readily and locking securely.

b. Interior wood doors shall not warp to exceed ¼ in. Exterior wood doors shall not warp to exceed ¼ in. Garage doors shall operate properly under normal conditions of use.

608–2 Exterior doors.

608–2.1 *Weatherstripping.*

All exterior doors and weatherstripping shall be properly fitted to eliminate excessive infiltration from open cracks.

608–2.2 *Miscellaneous.*

Provide a safety door check on all doors, including storm and screen doors, opening outward.

608–3 Windows.

608–3.1 *Installation.*

Windows shall be installed in accordance with the recommendations of the manufacturer. Operating hardware shall be installed. Caulk around frames with a nonhardening sealant. Windows shall operate with reasonable ease as intended. Condensation or frost on windows directly attributable to faulty installation is unacceptable.

608–3.2 *Weatherstripping.*

Windows and weatherstripping shall be properly fitted to eliminate excessive infiltration from open cracks.

608–3.3 *Screens.*

Install screens on openable windows in those areas where window screens are customarily provided.

608–4 Glazing.

Glazing shall comply with the latest Flat Glass Marketing Association's manuals: Glazing Manual and Glazing Sealing Systems Manual.

608–5 Metal Curtain Walls (See 605–5).

609 *Finish Materials.*

609–1 General.

Application of finish materials shall be such as to: prevent entrance or penetration of moisture or weather; provide adequate protection from damage by decay, corrosion, insects and other undesirable elements; and provide reasonable durability, economy of maintenance and an attractive appearance.

609–2 Exterior Wall Finishes.

609–2.1 *General.*

a. Exterior wall finishes shall be installed in a manner to restrict the entrance of moisture and weather. Joints between exterior trim elements, including siding, shall not result in open cracks in excess of ¼ in. In all cases, the exterior trim and siding shall be capable of performing its function to exclude the elements. Attachment and anchorage of finish to backing or structure shall be adequate to resist design wind forces. See 601–6.

b. Use of brittle or otherwise easily injured exterior finish materials shall be restricted to 7 ft 0 in. or more above grade where large numbers of children are anticipated or where the probability of damage to the exterior finish is considerable.

c. When sheathing is used for attachment of siding, see 606–5.4 and Table 6–6.5.

d. The separation, cracking or peeling of siding is not acceptable.

e. Siding shall not delaminate or deteriorate within manufacturer's specifications.

609–2.2 *Wood Siding, Hardboard, Plywood.*

a. Wood siding shall be applied with corrosion resistant nails which will penetrate 1 in. into studs, blocking or wood sheathing.

b. Headlap shall be adequate to prevent entrance of moisture into walls.

.c. Butt joints of horizontal sidings shall occur over studs, except where wood sheathing is used. Joints in adjacent pieces shall be staggered.

d. Max. spacing of studs or blocking shall be 24 in. for ⅜ in. square edge ungrooved hardboard panels with or without sheathing. For all other hardboard, max. spacing of studs or blocking shall be 16 in.

e. For spacing of supports for plywood sheathing and siding, see Table 6–6.3 and Appendix F.

609–2.3 *Wood Shakes and Shingles.*

a. Wood shakes and shingles shall be applied with corrosion resistant nails over suitable wood sheathing or to furring strips over fiberboard or gypsum sheathing.

b. Shakes and shingles shall be coursed and lapped in a manner to prevent the entrance of moisture.

609–2.4 *Asbestos Cement Siding.*

a. Application shall be over solid wood sheathing or over fiberboard or gypsum sheathing where nailing strips or other special fastening methods are used.

b. Headlap shall be adequate to prevent entrance of moisture into wall.

c. Use corrosion resistant nails of sufficient length to penetrate supporting materials.

d. Caulk all vertical joints where siding abutts other materials.

e. Installation of flat sheet siding shall be in accordance with the manufacturer's recommendations.

609–2.5 *Stucco (Exterior).*

Preparation and application shall comply with ANSI A42.2 and A42.3. Cracks in stucco walls shall not exceed ⅛ in. in width.

609–2.6 *Aluminum Siding.*

a. Application shall conform to AAMA 1403.2, Installation Specifications for Residential Aluminum Siding.

b. See 606–5.5 for sheathing paper requirements.

609–2.7 *Steel Siding.*

Steel siding conforming to Table 5–7.1 shall be applied over solid sheathing in accordance with the manufacturers specifications and the following:

a. Siding shall be vented by clips or starter strips.

b. J channels or L moldings shall be used at all openings and at extremity of any siding run where a corner is not employed.

609–3 Roof Coverings.

609–3.1 *General.*

a. Roofs shall not leak under normally anticipated conditions. Roof coverings shall restrict the entrance of moisture and weather, be resistant to deterioration, and provide an attractive appearance. Attachment or anchorage of covering to roof sheathing shall be adequate to resist design wind forces. See 601–6.

b. All roofing materials shall be installed in accordance with the recommendations of the manufacturer unless otherwise indicated in these MPS.

c. Nailing.

(1) Use corrosion resistant roofing nails suitable for the material being installed and of sufficient length to penetrate through sheathing or ½ in. into wood plank decks. Where sheathing is low density board sheathing (specific gravity less than 0.45, oven dry), screw thread or annular thread roofing nails shall be used. Where plywood sheathing is used, nails shall be as recommended by the manufacturers of the sheathing and roofing materials being installed.

(2) Stapling may be used in areas which are not subject to high or medium high winds (90 mph), and shall comply with UM-25. See Fig. 6–1.1 for wind areas.

d. In areas where the outside design temperature is 0 F or less and in areas where ice may form along eaves and cause a backup of water, eave protection shall be provided as follows:

(1) Slopes 4 in 12 or more: When overhang is less than 36 in., provide either one course of 90 lb mineral surfaced roll roofing or one course of 50 lb smooth roll roofing over the single underlay. Extend roll roofing a min. of 12 in. beyond inside face of wall. When overhang requires a roll roofing width greater than 36 in., the required horizontal laps shall be cemented and the roll roofing shall cover the underlay for all of that portion of the roof extending beyond the exterior wall line.

(2) Slopes less than 4 in 12: For overhangs of any width, that portion of the underlay extending from the eave to a point 24 in. beyond the interior wall face shall be double and cemented. A uniform continuous layer of plastic asphalt cement shall be applied with a comb trowel at a rate of 2 gals per 100 sq ft to the surface of the underlay starter course before the first full course is applied, and also to the 19 in. underlying portion of each succeeding course within the eave protection area.

e. Shingle Applications.

(1) A starting course providing double thickness at eave shall be used. Shingles shall project over edge of sheathing at eave and rake to form drip.

(2) Individual shingles shall have at least two nails per shingle.

(3) Avoid vertical alignment of shingle joints in alternate courses.

609–3.2 *Asphalt Shingles.*

Provide at least double coverage at all points. Cutouts and spacing between shingles not in excess of ¾ in. may be disregarded in determining double coverage.

b. Exposure shall be as required for ASTM E 108 Class C label.

c. Min. roof slope and underlay shall comply with Table 6–9.1.

TABLE 6–9.1—MINIMUM ROOF SLOPE AND UNDERLAY FOR ASPHALT SHINGLES

Underlay 15 lb 65 in. Endlap	Minimum Roof Slope (in,)	
	Double Coverage Singles	Triple Coverage Shingles
Not required.	7 in 12	4 in 12 (1)
Single, 2 in. Headlap.	4 in 12 (1)	3 in 12 (2)
Double, 19 in. Headlap.	2 in 12	2 in 12

Notes:

(1) May be 3 in 12 for porch roofs.

(2) May be 2 in 12 for porch roofs.

d. Nails shall have deformed, barbed or threaded shanks with heads not less than ⅜ in. diameter.

e. Square butt strip shingles shall have at least four nails per strip except that in areas subject to high winds (90 mph), provide 6 nails per strip.

f. Each shingle tab shall be secured to undercourse when roofing is subject to any of the following conditions:

(1) Roof slopes less than 4 in 12.

(2) All slopes subject to high or medium high winds (90 mph).

(3) All slopes in medium wind zone areas (80 mph), if shingles weight less than 275 lbs per square.

g. On roof slopes 4 to 12 and above in low or medium low wind zone areas (70 mph), secure tabs of shingles as required by Asphalt Roofing Manufacturers Association's publication, Manufacture, Selection and Application of Asphalt Roofing and Siding Products.

TABLE 6–9.2—WOOD SHINGLES

Shingle Length and Face Grade (1)	Minimum Thickness At Butt	Maximum Exposure (in.)	
		Slopes Less than 4 in 12 (Porches)	Slopes 4 to 12 and Over
16 in. #1	5 in. 2 in.	3 3/4	5
16 in. #2	5 in. 2 in.	3 1/2	4 18 in. #1
18 in. #1	5 in. 2 1/4 in.	4 1/4	5 1/2
18 in. #2	5 in. 2 1/4 in.	4	4 1/2
24 in. #1	4 in. 2 in.	5 3/4	7 1/2
24 in. #2	4 in. 2 in.	5 1/2	6 1/2

Notes:

(1) See 509–3.3 for undercourse grades.

609–3.3 *Wood Shingles.*

a. Min. roof slope 4 to 12 except porches which may be 3 to 12.

b. Size, grade, thickness, exposure and slope shall comply with Table 6–9.2.

c. Application.

(1) Lay approximately ¼ in. apart with a min. sidelap of 1½ in. in adjacent courses. Avoid vertical alignment in alternate courses. Double starter course.

(2) Underlay is not required except where eave protection is necessary. See 609–3.1d.

(3) Nails shall be located 1 to 1½ in. above the butt line of the following course and approximately ¾ in. from each edge.

609–3.4 *Wood Shakes.*

a. Min. roof slope, 4 in 12.

b. Size, max. exposure and min. thickness shall comply with Table 6–9.3.

c. Roof sheathing may be either spaced or solid, except that solid sheathing shall be used in areas where wind driven snow is encountered.

Table 6–9.3—WOOD SHAKES

Type	Length (in.)	Min. Thickness (in.)	Max. Thickness (in.)
Hand-split, and resawn	18	1/2	7 1/2
Tapersawn	24	1/2	10
Tapersplit	24	1/2	10
Straight-split	18	3/8	5 1/2
	24	3/8	7 1/2

d. Underlay.

(1) Between each course interlay an 18 in. wide layer of 15 lb or heavier asphalt-saturated felt with bottom edge positioned above shake butts a distance equal to double the weather exposure. End lap of underlay shall be at least 4 in. In areas where wind driven snow is not encountered, felt interlay is not required when straight-split or tapersplit shakes are applied at weather exposures less than ⅓ the total shake length.

(2) Install a 36 in. wide, 15 lb min. starter strip at eaves and a 12 in. wide, 15 lb min. strip over all hips and ridges.

e. Application.

(1) Lay approximately ¼ in. apart. Provide 1½ in. min. sidelap in adjacent courses.

(2) Nail each shake 1 to 2 in. above butts of the following course and approximately 1 in. from edges.

609–3.5 *Slate Shingles.*

Min. slope, 4 to 12 in., except porches which may be 3 to 12 in.

609–3.6 *Asbestos Cement Shingles.*

a. Size, thickness, max. exposure and min. lap shall comply with Table 6–9.4.

b. Nailing.

(1) Nails shall have ⅜ in. heads.

(2) Storm anchors used with dutch lap or ranch design shingles shall be copper, aluminum or lead, approximately ¾ in. long with flat base.

c. Min. roof slope and underlay shall be as shown in Table 6–9.5.

d. Underlay shall be 15 lb asphalt-saturated asbestos roofing felt or 30 lb asphalt-saturated organic felt.

TABLE 6–9.4—ASBESTOS-CEMENT SHINGLES

Type of Application	Size (in.)	Thickness (in.)	Minimum Lap (in.)		Maximum Exposure (in.)
			Head	Side	
Individual Unit	8 x 16	5/32 to 1/4	2	2	7
	9 x 18	1/4	2	2	8
Multiple Unit	14 x 30	5/32	2	-	8
Dutch Lap	16 x 16	5/32	3	4	12 x 13
Ranch Design	24 x 12	5/32	3	4	20 x 9
French	16 x 16	5/32	3	3	13 x 13

609–3.7 *Built-up Roofing.*

a. Quantity of materials and min. roof slopes per square of built-up roofing on wood sheathing or decks shall comply with Table 6–9.6.

b. Materials.

(1) Bituminous materials shall comply with 509–3.2.

(2) Aggregate shall be clean, durable gravel, crushed stone or air-cooled blast furnace slag complying with ASTM D 1863.

(3) Aggregate sized larger than ¾ in. may be used but shall not be included in required weight.

c. Application—Wood Decks.

(1) If underside of roof deck is finished ceiling surface, install one layer of unsaturated building paper over entire roof deck. Min. headlap, 2 in.

(2) Apply two dry plies of 15 lb felt or one dry ply of 30 lb felt, and three plies of 15 lb felt mopped down and mopped together. Over entire surface, apply a uniform flood coat of bitumen and embed surfacing aggregate.

(3) at 19 in. selvage, mineral surfaced, roll

roofing cap sheet may be used when installed over 2 mopped piles of No. 15 felt.

(4) Install metal gravel stop over dry or mopped sheets at eaves and rake.

(5) Where roofing serves as flashing at intersections of walls or chimneys, install cant strips and turn up roofing felts at least 4 in. Mop felts to intersections.

d. Application—Concrete Deck.

Installation shall be four plies of 15 lb roofing felt mopped down and mopped together. Weight of moppings and flood coat and weight of aggregate shall be same as for application to wood decks.

e. Application—Fiberboard Insulating Roof Deck

Comply with Table 6-6.5. In areas subject to high winds, special nails shall be used.

609-3.8 *Roofing Tile.*

a. Concrete roofing tile shall comply with the material and installation requirements of UM-17, Concrete Roofing Tile.

b. Clay roofing tile shall comply with the HUD field office requirements. Installation shall conform to manufacturer's recommendations.

c. Special application methods may be required by the HUD field office in areas subject to high winds.

TABLE 6-9.5—MINIMUM ROOF SLOPE AND UNDERLAY

Minimum Roof Slope (in.)	Underlay (2 in. headlap, 4 in. sidelap)
3 to 12	Double
4 to 12	Double in areas where the outside design temperature is 0 F or less, single in other areas
5 to 12 or more	Single

609-3.9 *Metal Roofing.*

a. Install over solid sheathing. Installation of standing or batten seam roofing shall be in accordance with Aluminum Sheet Metal Work in Building Construction issued by AA or with Architectural Sheet Metal Manual issued by SMACNA.

b. 15 lb asphalt-saturated felt underlay shall be installed over entire roof surface.

c. Min. roof slope:

(1) Aluminum shingles, 4 to 12.

(2) Large sheets:

(a) Standing or lock seam, 3 to 12.

(b) Corrugated or crimped type with lapped seams, 3 to 12.

d. Min. Lap.

(1) Corrugated or crimped type with lapped seams, 6 in. headlap and 1½ corrugations sidelap.

(2) Aluminum shingles, 6 in. headlap and endlap.

e. For zinc-copper alloy roofing, underlayment of vapor barrier building paper shall comply with FS W-P-147, Class C or better. Asphalt saturated felt or "breathing" paper shall not be used.

TABLE 6-9.6—BUILT-UP ROOFING

Roof Type	Minimum and Maximum Roof Slope	Bitumen Per Square: Average Mopping Coats	Bitumen Per Square: Minimum Flood Coat	Bitumen Per Square: Minimum Total Bitumen	Surfacing Per Square
Asphalt (Type I) and Aggregate	1/4 in 12 to 1 in 12	15-20 lbs Asphalt	60 lbs Asphalt	105 lbs Asphalt	400 lbs gravel or crushed rock or 300 lbs slag on level roof. 300 lbs gravel or crushed rock or 225 lbs slag at 3 in 12 roof slope. Proportional weight for intermediate roof slope.
Asphalt (Type II) and Aggregate	1 in 12 to 3 in 12	15-20 lbs Asphalt	50 lbs Asphalt	95 lbs Asphalt	
Coal Tar Pitch (Type I) and Aggregate	1/4 in 12 to 1/2 in 12 (1)	20-25 lbs Pitch	75 lbs Pitch	135 lbs Pitch	
Asphalt (Type II) and Cap Sheet	2 in 12 to 6 in 12	15-20 lbs Asphalt	None	45 lbs Asphalt	19" selvage, double coverage, mineral surface cap sheet

Note:

(1) Slopes less than ¼ to 12 are acceptable when roof is designed and constructed to avoid ponding and excessive deflection.

609-4 Interior Wall and Ceiling Finishes.

609-4.1 *General.*

Wall and ceiling finishes shall be suitably secured to a subbase or framing members. All accessories, trim, fittings and moldings shall be installed in accordance with manufacturer's directions. Joints in moldings or joints between moldings and adjacent surfaces shall not result in cracks exceeding ⅛ in. in width. Interior wall surfaces shall be free of obvious defects of poor workmanship resulting in blisters in tape or excess compound in joints, trowel marks and cracked corner beads.

609-4.2 *Ceramic Tile.*

a. Portland Cement Mortar Method. Installation of cement mortar and ceramic tile shall comply with ANSI A108.1, ANSI A108.2, and ANSI A108.3 and with TCA Handbook for Ceramic Tile Installation except the conventional three coat method over wood frame (scratch coat, setting bed and bond coat) min. thickness shall be ¾ in. total. One coat work (setting bed and bond coat min. thickness ⅜ in.) may be used over masonry, or other solid backing that provides firm anchorage for metal lath.

b. Thin-Setting Method

Ceramic tile installed with adhesives shall comply with ANSI A108.4, or when installed with dry-set portland cement mortar with ANSI A108.5 and with TCA Handbook for Ceramic Tile Installation except that when gypsum backing board is used at bathtubs and showers, special designed water-resistant gypsum backing board conforming with ASTM C 630 shall be used. Insulating (foil-backed) wallboard shall not be used for backing material.

609-4.3 *Gypsum Board.*

The finish and application of gypsum board shall comply with ASTM C840.

609-4.4 *Hardboard.*

a. Min. thickness, ¼ in. direct to framing, ⅛ in. over rigid backing.

b. Max. spacing of framing, 16 in. oc unless over rigid backing.

c. Provide solid backing for all edges. Fit panels to allow for expansion.

d. Nailing

Spacing nails 4 in. oc on along edges and 8 in. oc into intermediate framing. Min. edge distance, ⅜ in.

e. Adhesives or special fastenings may be used when installed in accordance with manufacturer's directions.

609-4.5 *Lath and Plaster.*

a. Furring, lathing, and plastering work shall conform to the following standards:

(1) Specification for Installation of Interior Lathing and Furring, ASTM C-841.

(2) Specification for Installation of Interior Gypsum Plaster, ASTM C-842.

(3) Specifications for Portland Cement Plastering, ANSI A42.2 and A42.3.

b. Run V groove on brown and finish coats around all metal trim, and at similar conditions.

609-4.6 *Plywood.*

a. Provide solid backing for all edges.

b. Max. spacing of supports:

(1) ¼ in. plywood, 16 in. oc. Plywood less than ¼ in. thick apply over rigid backing.

(2) ⅜ in. plywood, 24 in. oc.

c. Nailing.

(1) Length of nail shall be that which will provide at least ⅛ in. penetration into support.

(2) Space nails at least 8 in. oc on ceilings, 12 in. oc on walls. Min. edge distance, ⅜ in.

d. Adhesives or special fastenings may be used when installed in accordance with manufacturer's directions.

609-4.7 *Solid Wood Paneling.*

a. Apply over vapor barrier when application is direct to exterior wall framing or blocking.

b. Max. width, 12 in.

c. Min. thickness, ½ in.

d. Max. spacing of supports, 24 in. oc.

e. Nailing:

(1) Nail to each bearing with 11 or 12 ga casing or finishing at least ¾ in. penetration into support.

(2) Provide 2 nails at each bearing for boards less than 6 in. wide, and 3 nails in boards 6 in. and wider.

(3) Adhesives or special fastenings may be used when installed in accordance with manufacturer's directions.

609–4.8 *Plastic and Metal Wall Tile.*

Plastic and metal wall tile shall be backed by plaster complying with 609–4.5, or by gypsum board complying with 609–4.3, except at bathtubs and showers the plaster shall be portland cement and gypsum board shall be special designed water resistant, conforming with ASTM C 630. Insulating (foil-backed) gypsum board shall not be used. The tile shall be installed in accordance with manufacturer's directions.

609–4.9 *High Pressure Laminated Plastic Panel Systems*

a. Apply over plywood or other subbase material in accordance with panel manufacturer's recommendations.

b. Min. total thickness of the high pressure laminated plastic panel, 3/16 in.

609–4.10 *Fiberboard.*

a. Min. thickness and max. spacing of supports shall be as follows:

Thickness (in.)	Spacing of supports (in. oc)
1/2	16
3/4	24

b. Nailing.

(1) Nail with 11 or 12 ga casing or finishing nails. Length of nail shall be that which will provide at least ¾ in. penetration into support.

(2) Space nails 6 in. oc on ceilings, 8 in. oc on walls. Min. edge distance, ⅜ in.

c. Fastenings for special types of interior fiberboard finish may be used.

609–5 Finish Flooring, Rigid.

609–5.1 *General.*

Floors regardless of finish shall not be more than ¼ in. out of level within any 32 in. measurement. Floor slope within any room shall not exceed 1/240 of the room width. Installation of rigid finish floors shall be in conformance with recognized trade standards and shall provide a floor free of objectionable defects.

609–5.2 Installation of rigid finish flooring materials shall comply with the requirements of Table 6–9.7, 6–9.8, or 6–9.9 as applicable.

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TABLE 6-9.7---RIGID FINISH FLOORING

Material and Installation	Standards and Other Criteria
Ceramic Tile (1)	
Cement mortar	ANSI A108.1, A108.2, A108.3, - TCA. Min. thickness of setting bed over wood subfloor or over top of beveled joists, 1 1/4 in.
Thin setting method	ANSI A108.4, A108.5, A108.6, - TCA.
Shower receptor	ANSI A108.2, A108.3, - TCA. Use waterproofed building paper conforming to F.S. UU-B-790, with a copper or lead safe pan over a wood subfloor.
Terrazzo	
Monolithic and methods	Terrazzo Specifications, Details, Technical Data," NTMA.
Concrete	See 603

Note:
(1) Ceramic tile shall not crack or become loose.

TABLE 6-9.8---WOOD STRIP FLOORING

Min. Flooring Thickness (1)	Max. Support Spacing (2)	Application
Installation with Wood Board Subfloor		
5/16 in.	16 in.	Apply flooring at right angles to joists except when diagonal subfloor is used.
25/32 in.	24 in.	Apply board subfloor diagonally to supports; apply tongue and groove flooring at right angles to supports. supports.
Installation Direct to Supports (3)		
25/32 in.	16 in.	Apply tongue and groove flooring at right angles to supports. End joints shall break over supports unless end matched. If end matched, no adjoining strips shall break joints in the same space between supports. Each flooring strip shall bear on at least one support.

Notes:
(1) Max. width of flooring, 2 1/4 in., unless precautions are taken to prevent warping or cupping.
(2) Supports may be wood joists or 2 in. x 2 in. sleepers nailed or clipped to concrete slab.
(3) Use No. 15 asphalt-saturated felt or insulation with attached vapor.

TABLE 6-9.9---WOOD BLOCK FLOORING

Installation	Criteria
Nailing to Wood Subfloor	Use T & G flooring and T & G subfloor, underlayment optional
Adhesive, Wood Subfloor	Use T & G or square edge flooring over suitable underlayment
Adhesive, Concrete Slab	Use primer on concrete if asphalt type mastic used. Use no fiberboard or plastic sound isolation underlayment unless recommended by flooring manufacturer.

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609–6 Resilient Flooring.

609–6.1 *General.*

a. Resilient flooring shall not lift, bubble, become unglued or contain readily apparent nail pops.

b. Depressions or ridges in resilient flooring shall not exceed ⅛ in. The ridge or depression measurement is taken as the gap created at one end of a six-inch straight edge placed over the depression or ridge with three inches on one side of the deflect held tightly to the floor.

c. Gaps shall not exceed 1/16 in. in width in resilient floor covering joints. Where dissimilar materials abut, a gap shall not exceed ⅛ in.

609–6.2 Application shall be over a suitable underlayment and in compliance with the recommendations of the manufacturer.

609–6.3 Where resilient flooring is installed on a concrete slab-on-ground either above or below grade, see Interior Concrete Slabs-on-Ground, 603–4.

609–6.4 Seamless coating type flooring shall be installed in accordance with HUD–Assisted Housing Maintenance Guide on Seamless Coating System HM, G 7482.2.

609–6.5 In housing for the elderly, adjacent dissimilar materials shall be flush with each other to provide an unbroken surface. Thresholds and expansion joint covers shall be flush with the floor.

609–6.6 Floors in Housing and Facilities for Physically Handicapped People Shall Comply With ANSI A117.1.

609–7 Painting.

609–7.1 *General.*

a. Exterior paints or stains shall not fail during the first year.

b. Natural finishes or interior woodwork shall not deteriorate during the first year.

c. Interior paint shall be applied in a manner sufficient to visually cover wall, ceiling and trim surfaces where specified.

609–7.2 Application.

a. Application of paints, stains, or other coating systems shall be in strict accordance with manufacturer's directions. Ready-mixed paint shall not be thinned, except as permitted in the application instructions. These finishing systems may be field or factory applied.

b. Paint shall not be applied when the temperature is at or expected to be below 40° F.

c. Apply not less than the number of coats required herein for the specific application. Where the requirement is for a specified dry film thickness, number of coats shall be that necessary to obtain at least the required thickness. Additional coats may be required if the finish surface does not provide acceptable coverage or hiding.

609–7.3 *Exterior Wood Surfaces.*

Exterior wood surfaces shall be finished as follows:

a. Wood Siding, Millwork and Trim.

(1) Knots, resinous wood, and nail holes shall be sealed with a prepared sealer or aluminum paint prior to puttying and priming. Any nail holes or cracks in surfaces to be painted shall be filled with putty.

(2) Apply a prime coat to all surfaces to be painted before or immediately after installation. Primer shall be formulated specifically for application to unfinished wood. Finish coats formulated to serve as primers may be used.

(3) Apply one of the following finish systems. Coverage shall be that which will provide at least the min. thickness recommended by the manufacturer.

(a) Oil paint systems.

(b) Latex paint systems.

(c) Pigmented stains as per manufacturer's direction.

(d) Clear penetrating preservative or water repellent finishing system.

(4) Top and bottom of exterior wood doors, casement sash, awning sash and bottom of double hung sash shall receive two coats of paint or sealer.

(5) Prior to erection, seal all edges of vertical siding with a heavy coat of house paint primer, water repellent stain, exterior aluminum house paint or sealer.

b. Wood Shingles, Shakes, Roughsawn Siding. Apply two coats of oil stain, pigmented oil stain or an oil shingle paint.

c. Hardboard and Softwood Plywood Siding. Finish in accordance with manufacturer's directions.

d. Wood Porch Floors and Decks. Apply one coat of primer and two coats of floor and deck enamel designed for exterior use. Caulk joints between floor and wall.

e. Unfinished Surfaces. Shingles and board siding of vertical grain cedar, redwood and baldcypress may be left unfinished.

f. Soffits, porch and carport ceilings shall be finished as indicated in 609–7.3a.

609–7.4 *Exterior Concrete Masonry Units or Concrete Brick.*

a. Provide at least two coats of masonry paint.

b. Concrete masonry units or concrete brick, except small areas of foundation walls shall be painted to provide a water resistant finish. High density concrete brick or solid split block forming the outer face of double unit walls (veneer, cavity walls, etc.) may be left unpainted when acceptable to the HUD field office.

609–7.5 *Exterior Metal.*

a. Galvanized Steel or Iron. Field painting shall consist of a primer formulation specifically for galv surfaces and a finish coat. Finish coat formulated to serve as a primer may be used.

b. Steel, Iron or Terne Plate

(1) Steel or iron, except stainless steel, weathering steels, or steel treated with coatings to provide corrosion resistance, shall be painted.

(2) Apply a rust inhibitive primer and a finish coat.

609–7.6 *Interior Wood Surfaces.*

a. Millwork and Trim

(1) All millwork and trim including windows, interior doors, window, door and base trim, paneling, closet shelving and trim, etc., shall be finished by painting or natural finishing.

(2) If Painted

If surface is open grain wood, fill or seal to prevent grain rising. Prime surfaces with a primer. Apply one or more finish coats to provide a smooth surface having good hiding and coverage.

(3) If Finished Natural.

Natural finishes may be stain-wax, stain followed by one or more coats of varnish, clear coats of varnish with or without wiped paint undercoats or oil and wax finishes.

b. Wood Floors.

(1) If flooring is open grain wood, apply one coat of filler, wiping off excess.

(2) Finish flooring with:

(a) One or two coats of penetrating sealer and one coat of wax or

(b) Two coats of varnish and one coat of wax or

(c) Two coats of polyurethane or

(d) One or more coats of an acceptable proprietary finish which may be applied at the factory.

609–7.7 *Interior Plaster and Gypsum—Walls and Ceilings.*

a. Plaster surfaces may be painted, or covered or left unfinished except for surfaces of kitchens and baths. If painted, apply a finish coat over a primer-sealer unless finish coats are self-priming type.

b. Gypsum wallboard shall be covered. If painted, apply one coat of wallboard sealer unless finish coats are self-sealing type. Apply two finish coats over sealer. One finish coat, except in kitchen and baths, may be accepted if good coverage is obtained.

609–7.8 *Interior Metal.*

Non-ferrous metals or wrought iron may be painted or left unfinished. Other metals shall be painted in accordance with 609–7.5.

609–7.9 *Interior Concrete Floors.*

a. If painted, apply at least two coats of resin-emulsion paint, a solvent rubber paint or a floor and deck enamel. If oil paint is used, neutralize surface before painting.

b. Apply a coat of wax over paint, stain or integral finish.

609–8 Wall Coverings.

609–8.1 *General.*

Covering material shall be secured to a suitable base in accordance with manufacturer's directions.

609–8.2 *Wallpaper.*

a. Coat plaster walls with sizing before hanging.

b. Drywall shall be sealed with a coat of latex, oil or varnish base sealer, or other acceptable substitute.

c. Any peeling or bubbling of wallpaper is unacceptable.

609–9 Other Finishes.

609–9.1 *General.*

Other finishes shall be installed in accordance with manufacturer's directions.

609–9.2 *Carpeting and Cushioning.*

Wall-to-wall carpeting, installed as the primary floor covering, shall not come up or become loose at its points of attachment. Carpeting and cushioning shall be installed in accordance with the Essentials of Modern Carpet Installation, published by the Carpet and Rug Institute, Box 2048, Dalton, Georgia 30720. The carpet shall be installed over one of the following suitable underlayments.

a. A finish floor as provided and described in 509 and 609;

b. A troweled concrete floor;

c. Plywood subfloor complying with 506, top ply of plywood shall be at least "C–C plugged" grade;

d. Plywood, hardboard or particleboard underlayment over other subfloor described herein;

e. Other materials where they provide a smooth, hard, durable surface.

610 *Specialties.*

610–1 Factory-Built Fireplaces and Fireplace Stoves.

610–1.1 *General.*

All factory-built fireplaces, fireplace stoves and other devices and appliances burning solid fuels shall be provided with a source of combustion air from outside the conditioned atmosphere of the home, directed (1) into the combustion chamber proper, or (2) into the room and along the same wall close to the appliance. The combustion air supply duct shall be sized for the flow of air needed by the appliance and shall be equal to or larger in area than (1) the smoke pipe or connector pipe of the device, or (2) the air inlet opening of the device whichever is smaller.

610–1.2 *Factory-Built Fireplaces and Fireplace Stoves*

Factory-built fireplaces and fireplace stoves shall be listed and labeled by a nationally recognized testing laboratory and shall be installed in accordance with the conditions of the listing and the manufacturer's instructions.

610–2 Factory-Built Chimneys.

Factory-built chimneys shall be listed and labeled by a nationally recognized testing laboratory and shall be installed in conformity with the listing.

610–3 Packaged Incinerators.

Construction and installation of packaged incinerators shall comply with NFPA Standard No. 82, Federal and local air pollution standards and shall be structurally safe, durable, and suitable for the intended use.

611 *Equipment.*

611–1 Kitchen and Vanity Cabinets.

611–1.1 *General.*

a. All manufactured factory finished cabinets shall comply with ANSI A161.1, Recommended Minimum Construction and Performance Standards for Kitchen and Vanity Cabinets or equivalent standard.

All cabinets shall bear the label of an independent inspection agency that maintains continuous control over the testing and inspection of the cabinet.

The label shall identify the manufacturer's name or symbol and indicate compliance with the applicable standards.

b. Construction and installation of job and custom built cabinets shall be acceptable to the HUD field office providing the cabinets are equivalent in quality and construction to cabinets meeting the ANSI A161.1. standard.

611–1.2 *Counter Tops.*

a. Top material shall be securely bonded to a reinforced steel core or to ⅝ in. plywood or other equivalent material.

Countertops fabricated with high pressure laminate coverings shall not delaminate or have chips or surface cracks. The deck area joint may have a max. of 1/16 inch gap. All other areas of the joint may have a max. of 1/16 inch differential in surface alignment.

b. Top material shall be phenolic laminate, vinyl plastic covering, linoleum, ceramic tile, stainless steel or other material suitable for its intended use. At least a 3 in. back and end splash shall be provided against all abutting vertical surfaces which are not water and grease resistant. When back splash is omitted, joints at the juncture of counter top and vertical surfaces shall be tight and sealed.

c. All edges including sink and built-in surface units shall have a non-corrodible metal molding or other suitable edging.

611–2 Kitchen Equipment.

611–2.1 *Gas Appliances.*

Every fuel-burning gas appliance shall be installed in accordance with the approved testing and labeling agency requirements.

Appliances shall bear a permanent and legible factory applied nameplate on which the following shall appear:

a. The manufacturer's name or trademark.

b. The Btu rating.

c. The model and serial number.

d. Instructions for the lighting, operation and shut-down of the appliance.

e. The type of fuel approved for use with the appliance.

f. A seal indicating approval of the appliance by an approved testing agency, if acceptance is based on such approval.

611–2.2 *Electrical Appliances.*

Every major electric appliance shall bear a permanent and legible factory applied nameplate and shall be installed in accordance with the approved testing and labeling agency requirements.

Labeling shall indicate the following:

a. Name and trademark of the manufacturer.

b. The model number or equivalent.

c. The electrical rating in volts, amperes, and phase.

611–3 Sleeves for Air Conditioners.

When packaged air conditioners are to be used, i.e. those which are commonly installed in frames, install metal sleeves through the wall to permit installation of conditioners. The sleeves shall be of the type that can be closed tight if no equipment is installed, and can accommodate more than two different manufacturer's products of the same capacity.

611–4 Public Telephones.

Public telephones accessible to physically handicapped people shall comply with ANSI A117.1.

612 *Furnishings—Carpets and Mats.*

These items are covered in 609 Finish Materials.

613 *Special Construction.*

613–1 Definition.

For the purpose of this MPS, special construction is defined as all methods of construction which are not covered by the other Divisions or Appendices of this MPS.

613–2 Manufactured Housing.

613–2.1 *Structural Features.*

a. Factory or On-Site Fabricated Systems or Components covered by the Requirements of this MPS.

Structural features consisting of factory-fabricated systems or components assembled either at the factory or at the construction site, shall not be considered a special construction method if the total construction is covered by the standards given in the other Divisions or Appendices of Chapters 5 and 6 of this MPS, and can be inspected on-site for determination of compliance with this MPS.

b. Factory Fabricated Systems or Components not covered by this MPS.

HUD handbook 4950.1, Technical Suitability of Products Program Technical and Processing Procedures, describes procedures to be followed in order to obtain acceptance of special structural features of manufactured housing not covered by this MPS.

613–2.2 *Non-Structural Features.*

These features include methods of construction, systems, sub-systems, components, materials and processes which are not covered by this MPS, and whose acceptance cannot be determined by other provisions of this MPS and HUD Handbook 4950.1.

613–2.3 *Advanced and Innovative Features.*

The basis for design, fabrication, construction and acceptance of advanced and innovative systems, sub-systems, components, materials and processes shall be the performance criteria established by HUD in relation to the innovative nature of the system or element thereof. Likewise, the basis for acceptance of the inspection and compliance assurance by the sponsor shall be the criteria established by HUD for these purposes.

613–3 Fallout Shelters.

613–3.1 *General.*

Fallout shelters shall be designed and constructed in accordance with TR–20 (Vol. 1), Fallout Radiation Shielding, dated June 1976, published by Defense Civil Preparedness Agency (formerly the Office of Civil Defense), except as modified by this MPS.

613–3.2 *Modifications.*

a. Where reference is made to local codes, add "and all applicable HUD Standards."

b. The min. number of persons per dwelling shall be determined by the size and number of bedrooms. The master bedroom shall be counted as two (2) persons. The number of persons for other bedrooms shall be counted by the number of single beds that a room will accommodate.

c. Mechanical air blowers must be capable of being manually operable.

613–4 Swimming Pools.

Where semi-private swimming pools are proposed, design and construction shall comply with HUD Handbook 4940.1, Minimum Property Standards for Semi-Private Swimming Pools and Wading Pools.

615 *Mechanical.*

615–1 Construction.

615–1.1 *General.*

a. Provide mechanical systems which will assure safety of operation, convenience and comfort, protection from destructive elements, reasonable durability and economy, and adequate capacity and quality.

b. No leaks of any kind shall exist in any soil, waste, vent or water pipe.

c. No valve or faucet shall leak due to defects in material or workmanship.

d. Fixtures, appliances or fittings shall comply with their manufacturers standards.

615–1.2 *Standards.*

Except as modified herein, the design, construction, installation, adjusting and labeling of all equipment, accessories and appurtenances for heating and air conditioning shall comply with the applicable recognized standards given in Appendices C and E.

615–1.3 *Electrical Equipment.*

All electrical equipment shall be installed in accordance with the current National Electrical Code, NFPA 70.

615–1.4 *Distribution.*

Heating, ventilating and air conditioning systems shall be designed, installed, balanced, adjusted and controlled to provide for the distribution of conditioned air to all habitable rooms and other spaces in accordance with the calculated heat loss or gain of the spaces to be conditioned, and in proportion to fluctuations of outdoor temperature.

615–1.5 *Accessibility.*

All individual items of equipment and components thereof shall be 100% accessible for repair, removal or replacement without funtional impairment or dismantling of any adjoining major surfaces or assemblies.

615–1.6 *Noise.*

The dwelling shall be free of objectionable sound as provided in 24 CFR Part 51, Environmental Criteria and Standards. Equipment conforming to other sound level criteria referenced in these standards shall also be acceptable.

615–1.7 *Stairways.*

Heating equipment or open flame appliances shall not be installed under unprotected combustible stairways.

615–1.8 *Air Quality.*

Heating equipment chimney emissions shall meet applicable local, state and Federal ambient air quality and emissions standards.

615–2 Mechanical Ventilation.

615–2.1 *General.*

a. Section 615–2 applies to all mechanical ventilation systems whether required or optional.

b. Ventilation (either natural or mechanical) shall be provided in accordance with 402. Optional mechanical ventilation or air conditioning may be installed to supplement natural ventilation in living areas or attic.

c. Individual living area ventilating fans shall be controlled by an integral switch or by a wall switch, either independent or combined with light switch. Powered attic ventilators shall be controlled by a thermostat with an on-off switch in the living area.

d. Fan grilles shall be removable or hinged to permit access to fan and motor for cleaning, servicing, replacement, or repair.

e. Air discharge openings through roofs or exterior walls shall be protected against the entrance of rain and snow, birds, large insects and foreign objects. Automatic felted louvers or backdraft dampers shall be provided on other than attic ventilators to prevent a reverse flow of air when the fan is not in operation.

615–2.2 *Bathrooms.*

a. Where natural ventilation is not provided, mechanical exhaust ventilation shall be installed in accordance with 402–2. Air shall be discharged by an exhaust fan directly to the outdoors, or may be discharged into an attic space which is cross-vented with a total net free area of $\frac{1}{150}$ of the ceiling area.

b. Make-up air shall be provided to the bathroom by means of an air intake grille located in the lower part of the bathroom door or wall, or by undercutting the bathroom door. If an intake grille is installed, it shall be vision-proof. The make-up air opening shall by sized for the air volume requirements of the exhaust fan at a velocity not to exceed 500 fpm.

615–2.3 *Kitchens.*

a. Where natural ventilation is not provided, mechanical exhaust ventilation shall be provided in accordance with 402–2. Air shall be exhausted from the kitchen directly to the outdoors through a range hood or through a ceiling or wall exhaust grille.

b. Mechanical exhaust air intake openings (grilles) shall be located either:

(1) In the ceiling or wall not more than 4 ft from the center-line of the range,

(2) In the wall directly above the back of the range, or

(3) Integral with the range.

A metal collector hood of the size and height required by 615-2.4b may be optionally installed.

615–2.4 *Range Hoods.*

a. Mechanical kitchen exhaust range hoods shall be labeled and listed by a recognized testing and inspection agency, and installed in accordance with such listing.

b. Range hood shall be at least as long as the range, shall be at least 17 in. wide, and the bottom of the hood rim shall be not more than 30 in. above the range top.

c. Range hood fan shall have a min. capacity of 40 cfm per linear ft of hood length, except that when installed over a range located in an island or peninsula, fan shall have a min, capacity of 50 cfm per linear ft of hood length.

615–2.5 *Combustion Air.*

Furnaces, boilers and domestic water heaters energized by fossil fuels shall be sealed combustion types or shall be separated from the conditioned atmosphere of the home. Combustion and ventilating air shall be provided in the required amounts from outside the conditioned atmosphere of the home in accordance with the requirements of NFPA Standards 31 and 54.

615–3 Heating.

615–3.1 *Heat Loss Calculations.*

a. Calculations of heat loss shall be made in accordance with the data and procedures contained in the current ASHRAE Cooling and Heating Load Calculations Manual, ASHRAE Handbook, IBR Guides sponsored by the Hydronics Institute, ARI, SMACNA, reference. NEMA or NESCA, and the limitations set forth in 607–3. NAHB Research Foundation's Insulation Manual may be used as a reference.

b. Inside design temperature shall be not less than 70 F. Outside design temperature shall be that established by the ASHRAE Handbook at the 97 ½ % design value for the location involved or as determined by the HUD field office based upon its record of experience.

c. For housing for the elderly, inside design temperature shall not be less than 75° F in all habitable rooms and corridors when the outside temperature is at design level. Lower inside design temperatures may be used for storage rooms, work rooms, and other similar spaces.

615–3.2 *Hot Water and Steam Systems.*

a. Design and installation of the entire system shall be in accordance with the ASHRAE Guide or IBR Installation Guides.

b. Heating systems shall be installed with ¾ in. drains at all low points and with a vent at all high points to permit complete drainage of the entire system by gravity.

c. When make-up water is of such a quality that excessive corrosion or scaling is known to exist, a suitable water treatment system as recommended by WQA shall be provided.

d. One pipe system shall be installed in compliance with the recommendation of the manufacturer of the special one pipe system fittings used.

e. Radiators, convectors, baseboard radiation and other terminal heating devices shall be provided with an accessible control valve or damper.

f. Accessible means shall be provided for balancing the distribution of heat to all heated spaces. When a shutoff valve or baseboard or convector damper is combined with a balancing device, the balancing device shall provide a balanced distribution of heat at the adjusted max. opening of the control valve or damper. Series-loop systems, consisting of a single circuit serving baseboard type units on one floor level only, may be installed without balancing devices in the water circuit, but shall have dampers for the air convection control.

g. Boiler insulation shall have a minimum thermal resistance (R) of 2 (hr x sq ft x F)/Btu.

h. Supply and return piping in unheated attic spaces, ventilated crawl spaces, and other exposed locations shall be insulated. The thermal resistance (R) value of the insulation shall be based on insulation material having an R value in the range between 4.0 and 4.6 (hr x sq ft x F)/Btu per in. of thickness of a flat plate at a mean temperature of 75° F. Heating pipes ¾ in. thick insulation.

i. Insulation on heating piping in insulated crawl spaces may be omitted where closable vents are provided.

615–3.3 *Warm Air Heating Systems—General.*

a. Design of all warm air heating systems shall be in accordance with the recommendations of the ASHRAE Guide or applicable manuals of SMACNA, ACCA and ARI. Installations shall comply with NFPA Standards 90B, 31 and 54.

b. Duct insulation is covered in 515–2.1.

615–3.4 *Warm Air Heating—Air Control.*

a. Provide all but one supply air outlet with a shutoff damper.

b. Provide an accessible balancing damper, either behind the supply air register or in the duct. The damper shall be either a friction fit or locking type and shall be adjustable. The position of the damper shall be indicated by an adjustment arm outside the duct or shall be visible for adjustment when the air outlet is removed.

615–3.5 *Warm Air Heating—Return Air.*

a. A return air inlet shall not be provided in a bathroom, kitchen, garage, utility space, a space used for fuel or flammable storage, or a confined space in which a draft diverter or draft regulator is located, or to which combustion air is supplied. Otherwise, all other habitable spaces shall be provided with an access to a return inlet.

b. Return air from any living unit shall not be delivered to or pass through any other living unit.

615–3.6 *Warm Air Heating—Perimeter Systems—Slab-on-Grade.*

a. Perimeter heating ducts shall be completely encased in not less than 2 in. of concrete except when the duct is of concrete pipe, ceramic tile, asbestos-cement or other materials acceptable to the HUD field office. All ducts imbedded in slabs shall have a min. of 2½ in. of concrete above the duct.

b. When the bottom of ductwork adjacent to the perimeter of the slab is at or above exterior finish grade, ducts and fittings (except within two duct diameters of the supplying plenum) may be of any suitable, non-combustible material not subject to deterioration or mildew in the presence of moisture.

c. When the bottom of ductwork adjacent to the slab perimeter is below exterior finish grade, the duct system wholly or partially below such grade shall be of ceramic tile pipe conforming to ASTM C 700, asbestos-cement pipe conforming to ASTM C 428 or concrete pipe conforming to ASTM C 14. Joints which are wholly or partly below exterior grade shall be watertight. Taped or cement grouted joints are not considered watertight.

615–3.7 *Warm Air Hearing—Underfloor Plenum.*

a. When underfloor space is used as a supply plenum, a clearance of at least 1 in. shall be maintained between furnace plenum and joists, beams, or any combustible construction.

b. The construction enclosing an underfloor plenum shall be sealed against air leakage and the ground surface shall be covered with a vapor retarder material. When plastic film is used, joints shall be lapped at least 2 in. when not sealed. The ground cover material shall have a flame spread classification not exceeding 200, unless it is covered with at least 2 in. of sand.

c. Unless the ground is covered with at least 2 in. of sand, there shall be firmly placed and secured under each floor opening into the plenum a noncombustible receptacle at least 3 in. wider than the opening and having 1 in. vertical lips all around.

d. The perimeter wall shall be insulated in accordance with 607–3.

e. Fuel-burning devices shall not be installed in a plenum. All material enclosing the underfloor space, including perimeter wall insulation, shall have a flame spread classification not exceeding 200.

615–3.8 *Warm Air Heating—Self-Contained Units.*

a. Self-contained heating units, such as room or space heaters, and recessed heaters, may be installed in single story structures, and also in split-level or two story structures provided that head distribution is achieved throughout the building.

b. There shall be not more than one doorway or one archway between the heater outlet and any space or room to be heated by it.

c. The distance between the heater outlet and the center of any space to be heated by it shall not exceed 20 ft. measured through the center of the intervening opening. This distance may be increased at the discretion of the HUD field office for locations having outside design temperaturs of 20° F. or higher.

d. Dampers designed to restrict warm air flow self-contained heaters having a single outlet shall not be installed. Dampers for heaters with two or more outlets shall be designed to limit warm air flow to no more than 50% of the total area of all outlets.

e. Thermostats for the control of self-contained heaters shall be located in the space or room in which the principal heater outlet is located.

615–3.9 *Electric Heating.*

a. All electric heating installations shall comply with NEC. When a recognized industry certification of testing program is available for heating units, systems and components, such equipment shall be labeled to show conformance. Test results to verify uncertified equipment shall be made available to the HUD field office upon request.

b. The average heat output of an electric heating unit shall not exceed the heat output rate permitted by the listed rating.

c. Thermostatic control for electric heating shall be provided in each heated room or space except when a central electric heating system is installed.

d. The wattage rating of electric heating units shall not exceed the rating of the controlling thermostat and/or relay conbination.

e. All resistance heating cables and prefabricated electric conductive panels shall bear a label identifying the manufacturer and rating of each unit. Cable shall be of standard lengths and shall not be cut. Prefabricated electric conductive panels shall not be cut, and lighting fixtures shall not be fastened to nor cut into the active area of the panel. Panels and cables shall be thermostatically controlled.

f. Bathroom wall heaters and switches shall be located as far as practicable from plumbing fixtures, and at least 30 in. from tub or shower.

615–3.10 *Oil Fired Equipment.*

a. Installation of fuel oil burners, oil tanks, and piping shall comply with NFPA Standard No. 31.

b. Oil fired equipment, unless otherwise listed by a qualified testing, rating and listing agency, shall be equipped with a listed barometric draft regulator.

c. Type L vents may be used with oil fired equipment when listed as being suitable for such venting use.

615–3.11 *Gas Fired Equipment.*

a. All gas fired heating equipment including conversion burners, vents and convectors shall be labeled, listed and installed in conformance with the appropriate ANSI/UL, AGA, or NFPA requirements and the manufacturers instructions.

b. All gas fired heaters shall be vented.

c. Above-roof enclosures or housing shall not be installed in connection with single wall metal pipe used for venting gas applicances.

d. Unless provided in the listing, no gas vent shall terminate less than 5 ft. in vertical height above the highest draft hood on connected applicances.

615–3.12 *LP Gas Containers and Piping.*

The construction and installation of storage containers and service piping for liquefied petroleum gases shall comply with NFPA 58.

615–4 Mechanical Cooling.

615–4.1 *General.*

a. These standards apply to mechanical or absorption-type refrigeration equipment providing summer air conditioning by either a central system with distribution ducts or piping, or packaged room or zonal air conditioners with free air discharge. They do not apply to evaporative coolers.

b. For requirements pertaining to individual air cooling units for single rooms, see 515–4.

c. The capacity of the system and its equipment shall be as recommended by ARI, ASHRAE, and ACCA.

d. Suitable and durable means shall be provided to prevent transmission of objectionable noise or vibration generated by the system or equipment. See 515–4.5 and 615–1.6.

615–4.2 *Heat Gain Calculations.*

a. Calculations shall be made in accordance with SMACNA, ARI and ACCA Manuals, the ASHRAE Handbook or the ASHRAE Cooling and Heating Load Calculation Manual.

b. Average inside design temperature shall be 75° F. dry bulb.

c. Heat gain calculations shall be made using the summer design dry bulb at 2½% as shown in the current ASHRAE Handbook.

615–4.3 *Air Distribution Systems.*

a. Duct insulation is covered in 515–2.1.

b. For underfloor plenum systems suitable for both cooling and heating, see 615–3.7.

c. Return air inlets shall be of sufficient number and so located that return air will not cause objectionable drafts. Grilles for return air shall be sized so that the velocity of air will not exceed 500 fpm. When multiple return air ducts are installed, they shall include dampers to balance the designed air flow.

d. Cooling coils shall be locaed so that conditioned air leaving the coil will not pass over the heat transfer surface of any furnace. Exception: Factory assembled units which are specifically tested and listed for this type of service.

e. The requirements of 615–3.3a, 615–3.3b, 615–3.4b, and 615–3.5b are also applicable to cooling air distribution systems.

615–4.4 *Coolant Distribution Systems.*

a. Distribution systems employing liquid media for cooling shall be designed in accordance with the applicable criteria contained in the ASHRAE Handbook and shall be capable of producting summer comfort conditions within the concept of this standard. Coolant lines shall be insulated with a min. ½ in. thick material having a vapor transmission rate not in excess of 0.1 perms. The thermal resistance (R) value of the insulation shall be based on insulation material having an R value in the range between 4.0 and 4.6 per in. of thickness of a flat surface at a mean temperature of 75° F.

b. All exposed refrigeration piping located less that 6 ft. above any floor or outside grade shall be suitably protected to prevent damage to piping or injury to persons.

c. Where condenser cooling water is known to cause excessive corrosion, scaling or obstruction within the piping or equipment, suitable approved water-treatment means will be required by the HUD field office. Dielectric connectors shall be used between ferrous and non-ferrous piping in the cooling water circuit.

d. Suitable means shall be provided for the collection and disposal of condensate from

cooling equipment. The condensate drain shall be at least ¾ in. nominal pipe size and of corrosion-resistant material.

e. Where the cooling coil or air-conditioning unit is located above a habitable space, or where structural damage may result from condensate overflow, an additional watertight pan of corrosion-resistant matal shall be installed beneath the cooling coil or unit to catch overflow condensate due to a clogged condensate drain; or one pan with standing overflow and separate drain may be provided in lieu of the second drain pan. The additional pan, or the standing overflow, shall be provided with a drain pipe, min. ¾ in. nominal pipe size, discharging at a point which can be readily observed.

615–4.5 *Electrical Equipment.*

Motors shall conform to Standard for Air Conditioners, Central Cooling Standard, ANSI/UL No. 465.

615–4.6 *Guarantee.*

Standard manufacturer's warranty shall be provided for all equipment and remain effective regardless of change of ownership.

615–5 Plumbing.

615–5.1 *General.*

a. Except as modified herein, plumbing and water supply systems, equipment and materials shall be installed in accordance with the prevailing model plumbing code having jurisdiction in the area. In the design of water using devices, water volume conservation shall be considered.

b. Hot and cold water shall be supplied to all plumbing fixtures except water closets which will be supplied with cold water.

615–5.2 *Fixtures.*

a. All fixtures shall be securely supported so that no strain is placed on the connected piping. Unless otherwise recommended by the manufacturer, bathtub rims at wall shall be supported on metal hangers or wood blocks secured to wall construction.

b. Drinking Fountains Accessible to Physically Handicapped People Shall Comply With ANSI A117.1

c. Waterproof shower safe pans shall be installed under all manonry shower receptors except those conforming with the test procedures contained in Appendix D.

d. Shower safe pans shall be formed of:

(1) Sheet lead or sheet copper heavily coated on both sides with an asphalt compound;

(2) Non-metallic material qualifying under test procedure in Appendix D.

(3) Hot-mopped asphalt pan conforming with CTI Standard Specifications for the Installation of Tile Lined Receptors, CTI R6–103.

e. Safe pans laid on wood floors shall be protected against nail popping by two layers of 15 lb. or one layer of 30 lb. asphalt-saturated felt.

f. Sides of pans shall be turned up a min. of 6 in. Corners may be formed by folding.

g. Shower heads shall have flow controls complying with ANSI A112.

h. Faucets at lavatories and kitchen sinks shall have flow controls complying with ANSI A112.

615–5.3 *Piping.*

a. Water service to each living unit shall be not less than ¾ in. pipe or tubing.

b. Water service pipe shall be laid on solid ground below frost line. Service pipe may be laid in same trench with sewer pipe provided it is laid on a shelf of solid earth at least 1 ft. above the sewer pipe. Service trenches shall be filled with earth free of cinders, wood, rocks or other debris.

c. Piping shall not be installed in or below cinders.

d. Piping installed in corrosive soil shall be either of a material unaffected by such soil or shall be isolated from it by a protective coating. The coating and its application shall conform to AWWA C–203.

e. Underground threaded joints in ferrous pipe shall be coated and wrapped. Coating and wrapping material and its application shall confrom with AWWA C–203.

f. Piping shall be installed without critical damage to structural members. See 606–4.

g. Pipe hangers and supports shall be of material similar to that of the piping. Dielectric insulating fittings shall be used where pipe of dissimilar metals are connected.

h. Piping shall be properly sloped and arranged for draining.

i. Cold water piping installed in locations of the building subject to freezing temperatures, or where pipe sweating may create a problem shall be insulated and covered with a vapor barrier. Drain, waste and vent or water pipes shall be adequately insulated to prevent freezing during normally anticipated cold weather.

615–5.4 *Valves and Fittings.*

a. Shutoff valve and drain accessible for operation by the occupant shall be provided in the water service pipe to each living unit. Also provide shutoff valves in the branch pipe to each water closet and to the water heater.

b. A non-syphoning type ball cock or other anti-syphon device acceptable to the HUD field office shall be provided for water closets.

c. Provide at least two hose bibbs at convenient exterior locations except where special configuration (duplex with units one above the other, triplex, quadruplex, etc.) of living units obviates need for the second hose bibb. In areas where hose bibbs are likely to freeze, they shall be of the frostproof type or have an individual stop and waste valve. Back siphonage protection shall be provided.

d. When normal street main water pressure exceeds 80 psi, a pressure reducing valve acceptable to the local code authority shall be provided in the water service pipe to reduce the water pressure to not more than 80 psi.

615–6 Domestic Water Heating Systems and Storage.

615–6.1 *Water Heater Capacities.*

The capacity of the water heater shall be based on the hourly consumption for the household in accordance with the table in the ASHRAE Handbook. This shall take into consideration the number of persons and the quantity of water needed for the household chores.

615–6.2 *Controls and Safety Devices.*

a. All individual direct-fired, automatic storage-type water heaters, including electrical shall be provided, at the time of installation, with a reseating type temperature and pressure relief valve constructed, listed, and installed in accordance with ANSI Z21.22. This requirement is in addition to the energy cutoff device installed by the heater manufacturer in conformance with appropriate standards.

b. All tankless indirect water heater installations shall include a thermostatic mixing valve to regulate the heated domestic water. When a check valve, pressure regulator or other backflow preventive device is installed between the heater and the street main or other water source, a pressure relief valve shall be installed between the heater and such valve, regulator or device.

c. Indirect water heater installations shall include operating controls for the heat source, of the type recommended by the boiler manufacturer. The installation shall be made in accordance with the boiler manufacturer's instructions.

d. The pressure relief elements of relief valves shall be set to open at not less than 25 psi in excess of available or system water pressure. Setting shall not exceed tank working pressure.

e. Relief valves shall be piped to discharge by gravity through an air gap into a plumbing fixture or floor drain. In those installations where neither floor drain nor plumbing fixture has been provided or, for some reason may be inaccessible, the relief valve discharge shall then be piped through an exterior wall, terminating in an elbow turned to discharge downward and shall be located approximately 1 ft above the exterior grade. Discharge piping shall be the same size as relief valve outlet.

f. For housing for the elderly, provide automatic temperature limit controls so that hot water for showers shall not exceed 110 F.

615–6.3 *Tank Connections.*

The heater tank connections shall be stainless steel, copper-lined steel, brass, or copperplated steel threated pipe nipples equipped with electrically inert waterway permanently fixed to each nipple. Dip tube may be metallic, electically insulated from the tank, or non-metallic conforming to ANSI Z21.10. Copper dip tubes may be used with brass nipples without dielectric fittings in copper tanks.

615–7 Special Piping Systems.

615–7.1 *Gas Transmission.*

Gas transmission systems shall be installed to obtain not less than the level of safety performance required by Part 192, Title 49, Code of Federal Regulations entitled, Transportation of Natural or Other Gas by Pipeline. Liquid petroleum pipelines shall conform to 49 CFR, Part 195. See 307–1.1.

615–7.2 *Gas Service Piping.*

Gas service piping installations shall be installed in a separate trench. Joints between lines of dissimilar metals shall electrically isolate one metal from the other.

615–7.3 *Steel and Iron Piping.*

All steel and wrought iron piping for gas service shall be coated and protected against corrosion as recommended in AWWA C–203.

615–7.4 *Plastic Pipe.*

Plastic pipe for gas service lines shall terminate below ground at foundation wall.

615–7.5 *Dielectric Fittings.*

Dielectric insulating fittings shall be provided on service side of gas meters when dissimilar metals are connected.

615–8 Water Supply System.

615–8.1 *General.*

a. Provide each living unit with a continuing and sufficient supply of safe water under adequate pressure and of appropriate quality for all household uses, and one that will not impair the function or durability of the plumbing system of attachments.

b. With respect to safe water, the chemical and bacteriological standards of the health authority having jurisdiction shall apply. In the absence of such standards, the max. contaminant levels of EPA shall apply.

c. Whenever feasible, connection shall be made to a public water system. When a public system is not available, connection shall be made when feasible to a community system which shall comply with HUD Handbook 4940.2.

615–8.2 *Individual Water Systems.*

a. The system should be capable of delivering a flow of 5 gpm over at least a 4 hr period.

b. Water quality shall meet the chemical and bacteriological requirements of the health authority having jurisdiction. If the local health department having jurisdiction does not not have chemical and physical standards, the max. contaminant levels of EPA shall apply. A water analysis may be required by either the health authority or the HUD field office.

c. Water that requires continuing or repetitive treatment to be safe bacterially is not acceptable.

d. After installation, the system shall be disinfected in accordance with the recommendations of the health authority. In absence of a health authority, system cleaning and disinfection shall conform to the current EPA Manual of Individual Water Supply Systems.

e. Bacteriological examination of a water sample collected by a representative of the local or state health authority shall be made when required by that authority or the HUD field office.

f. Any method for individual water supply contained herein which is not permitted by the local health authority having jurisdiction shall not be used.

615–8.3 *Location of Well.*

a. A well located within the foundation walls of a dwelling is not acceptable except in arctic and sub-arctic regions.

b. Water which comes from any soil formation which may be polluted or contaminated or is fissured or creviced or which is less than 20 ft below the natural ground surface (subject to the requirements of the local health authority) is not acceptable.

c. Individual water supply systems are not acceptable for individual lots in areas where chemical soil poisoning is practiced if the overburden of soil between the ground surface and the water bearing strata is coarse-grained sand, gravel, or porous rock, or is creviced in a manner which will permit the recharge water to carry the toxicants into the zone of saturation.

d. Table 6–15.1 shall be used in establishing the min. acceptable distances between wells and sources of pollution located on either the same or adjoining lots. These distances may be increased by either the health authority having jurisdiction or the HUD field office.

615–8.4 *Well Construction.*

a. The well shall be constructed to allow the pump to be easily placed and to function properly.

b. All drilled wells shall be provided with a sound, durable and watertight casing capable to sustaining the loads imposed.

The casing shall extend from a point several ft below the water level at drawdown or from an impervious strata above the water level, to 12 in. above either the ground surface or the pump room floor. The casing shall be sealed at the upper opening.

c. Board wells shall be lined with concrete, vitrified clay, or equivalent materials.

d. The space between the casing or liner and the wall of the well hole shall be sealed with cement grout.

e. The well casing shall not be used to convey water except under positive pressure. A separate drop pipe shall be used for the suction line.

f. When sand or silt is encountered in the water-bearing formation, the well shall either be gravel packed, or a removable strainer or screen shall be installed.

g. The surface of the ground above and around the well shall be graded to drain surface water away from the well.

h. Openings in the casing, cap, or concrete cover for the entrance of pipes, pump or manholes, shall be made water-tight.

i. If a breather is provided, it shall extend above the highest level to which surface water may rise. The breather shall be watertight, and the open end shall be screened and positioned to prevent entry of dust, insects and foreign objects.

TABLE 6–15.1—DISTANCE FROM SOURCE OF POLLUTION

Source of Pollution	Min. Horizontal Distance (ft)
Property Line	10
Septic Tank	50
Absorption Field	100 (1)
Seepage Pit	100 (1)
Absorption Bed	100 (1)
Sewer Lines w/ Permanent Watertight Joints	10
Other Sewer Lines	50
Chemically Poisoned Soil	100 (1)
Dry Well	50
Other	--- (2)

Notes to Table 6–15.1:

(1) The horizontal distance between the sewage absorption system and the well, or the chemically poisoned soil and the well, may be reduced to 50 ft only where the ground surface is effectively separated from the water bearing formation by an extensive, continuous impervious strata of clay, hardpan, or rock. The well shall be constructed so as to prevent the entrance of surface water and contaminants.

(2) Recommendation of local health authority.

615–8.5 *Pump and Equipment.*

a. Pump shall be capable of delivering the volume of water required herein under normal operating pressure within the living unit. Pump capacity shall not exceed the output of the well.

b. Pump and equipment shall be mounted to be free of objectionable noises, vibrations, flooding, pollution, and freezing.

c. Suction lines shall terminate below max. drawdown of the water level in the well.

d. Horizontal segments of suction line shall be placed below the frost line in a sealed casing pipe or in at least 4 in. of concrete. The distance from suction line to sources of pollution shall be not less than shown in Table 6–15.1.

615–8.6 *Storage Tanks.*

a. Provide a pressure tank having a min. capacity of 42 gals. However, prepressured tanks and other pressurizing devices are acceptable provided that delivery between pump cycles equals or exceeds that of a 42 gal. tank.

b. Tanks shall be equipped with a clean-out plug at the lowest point, and a suitable pressure relief valve.

615–9 *Sewage Disposal System.*

615–9.1 *General.*

a. Provide each living unit with a water-carried system adequate to dispose of domestic wastes in a manner which will not create a nuisance, contaminate any existing or prospective water source or water supply, or in any way endanger the public health.

b. Whenever feasible, connection shall be made to a publicly owned system.

c. When a public system is not available or connection thereto is not feasible, connection shall be made to a community system, if feasible. Such system shall comply with HUD Handbook 4940.3. All public and community systems shall be approved by the state health and pollution control authorities and the local health department.

d. When service from an acceptable public or community system is not available or feasible, and ground water and soil conditions meet the requirements of this standard, an individual system may be accepted by the HUD field office provided it is installed in accordance with the requirements contained herein.

e. An individual system which is acceptable herein but which is not permitted by the local health authority having jurisdiction shall not be used. Evidence of approval by such authority for each completed system will be required in all cases.

f. Septic system shall be capable of properly handling normal flow of household effluent. Sewers, fixtures and drains shall operate properly.

615–9.2 *Individual Systems—General.*

a. No part of the system shall be installed closer to other features of the property than the min. distances shown in Table 6–15.2.

b. Installation of individual systems in swampy areas, areas with a high water table (permanent, fluctuating or seasonal), areas with ledge rock or areas which are subject to flooding is not acceptable.

c. The type of system shall be determined on the basis of location, topography, soil absorbency and the depth and fluctuation of the ground-water level.

d. Each individual sewage-disposal system shall consist of a house sewer, a septic tank, and acceptable absorption system (subsurface absorption field, seepage pit or pits, or subsurface absorption bed). The system shall be designed to receive all sanitary sewage (bathrooms, kitchen and laundry) from the dwelling, but not footing or roof drainage. It shall be designed so that gases generated anywhere in the system can easily flow back to the building sewer stack.

e. The structural design and materials used in the construction of septic tanks and seepage pits shall be in accordance with generally accepted good structural engineering practice providing a sound, durable structure which will safely sustain all the dead loads, live loads, and liquid and earth pressures involved in each case.

TABLE 6–15.2—MIN. DISTANCES (FT)

FROM	TO			
	Septic Tank	Absorption Field	Seepage Pit	Absorption Bed
Well	50	100	100	100
Property line	10	5	10	10
Foundation	5	5	20	5
Water lines	10	10	10	10
Seepage pit	6	6	3 Diameters	—
Dry well	20	20	20	20

615–9.3 *House Sewer.*

a. The house sewer shall be installed in accordance with the nationally recognized model plumbing code having jurisdiction in the area. State and local codes which deviate from nationally recognized plumbing codes or standards in order to satisfy local conditions may be accepted by the HUD field office if such deviations are identified and substantiated with satisfactory engineering data.

b. The house sewer shall have watertight joints. It shall be on a grade of not less than ⅛ in. per ft.

c. The generally recognized practices for good pipe installation outlined in ASTM D2316 shall be followed.

TABLE 6–15.3—SEPTIC TANK CAPACITY

Number of Bedrooms	Min. Capacity (Gals)
2 or less	750
3	900
4	1000
each additional bedroom add	250

615–9.4 *Septic Tank.*

a. The design shall provide adequate volume for settling, for sludge and scum storage, and access for cleaning. The structural design shall provide for a sound, durable tank which will sustain all loads and pressures, and will resist corrosion. The HUD field office may require a test for watertightness and strength.

b. Liquid capacity shall be based on the number of bedrooms proposed or reasonably anticipated and shall be at least as required in Table 6–15.3. The liquid depth of the tank or a compartment thereof shall be not less than 30 in. A liquid depth greater than 6 ft. shall not be considered in determining tank capacity.

c. No tank or compartment thereof shall have an inside horizontal dimension less than 24 in. Scum storage volume shall be not less than 15% of the required liquid capacity.

d. Inlet and outlet connections shall be submerged or baffled. The inlet invert shall be at least 1 in. above the outlet invert.

e. Baffles, and pipe fittings used as baffles, shall extend upward to within 1 in. of the underside of the cover, and downward to a point of 40% of the liquid depth below the liquid surface. If an outlet fitting has no opening above the liquid level of the tank through which the tank scum layer could enter, the 1 in. clearance to the underside of the cover is not required. When a partition wall is used to subdivide the tank, it shall have a 4 in. diameter min. opening, with the same invert elevation as the tank outlet. The partition wall opening shall have an outlet device equivalent to the tank inlet our outlet, so that outside air can enter both sides of the partition.

f. When multi-compartment tanks are used, the volume of the first compartment shall be equal to or greater than that of any compartment.

g. Access to each compartment of the tank shall be provided by a 16 in. min. manhole or removable cover. The inlet and outlet connections shall also be accessible through properly placed manholes, handholes or by easily removable covers.

h. Provide a min. of 4 in. of soil over the top of the septic tank for growing grass. Where the top of the tank is lower than 18 in. below grade, manholes shall be built up to within 18 in. of grade.

615–9.5 *Percolation Tests.*

a. Percolation tests shall be conducted in accordance with the procedure given in Appendix D.

b. For individual lots, one percolation test per lot is required as a min. provided the soil is uniform and of one type. Where the soil is not uniform or there are more than one type of soil on the lot, one percolation test per lot is required as a min. at the center of each variation of type of soil of significant size.

c. For subdivisions or multiple lots, one percolation test per acre is required as a min. for each area consisting of a uniform solid of one type.

d. Test results and soil evaluation shall be used by the HUD field office to determine suitability for a soil absorption system and the type, design and size of the system to be installed.

615–9.6 *Subsurface Absorption Field.*

a. Where percolation rates (Table 6–15.5) and soil characteristics and site conditions are acceptable to the HUD field office an absorption field may be installed in an area which is well drained, has an acceptable slope, and is acceptable for excavation.

b. Size and spacing of trenches and area of the absorption field shall comply with Tables 6–15.4 and 6–15.5. Other characteristics shall comply with Table 6–15.6. The areas in Table 6–15.5 provide for plumbing fixtures and appliances common in residential use, including automatic sequence washer, mechanical garbage grinder, and dishwasher.

c. Where permeable soil formations are encountered, especially near existing wells, the distance between the well and the proposed absorption field as given in Table 6–15.2, shall be increased as required by the HUD field office.

d. Effluent from the septic tank shall be conducted to the absorption field through a watertight line with a grade of at least ¼ in. per foot. Tees, wyes or other distributing devices shall be of sufficient size to accommodate the necessary field lateral lines. The invert of all outlets shall be level and the inlet invert shall be at least 1 in. above the outlet invert.

e. That portion of an absorption trench below the top of the distribution pipe shall be in natural or acceptably stabilized earth such as GW, GP, SW, or SP, as defined in HUD Handbook 4075.8. The HUD field office may require special precautions, including tests, especially if other granular soils are used.

f. In locations where the absorption field is almost level (6 in. or less fall in any direction) the trenches shall be connected to form a continuous system with trench bottoms level.

g. In locations where the ground over the absorption field area slopes greater than 6 in., within the field, a system of serial distribution trenches following the contours of the land may be used. Trenches may be installed at different elevations, but the bottom of each individual trench shall be level throughout its length. Trenches shall be

connected with a watertight overflow line such that a trench will be filled with sewage to the depth of the gravel before the sewage flows to the next lower trench. At the point where an overflow pipe leaves an absorption trench, the trench for this pipe shall be dug no deeper than the top of the soil-gravel interface. The inlet shall be placed as far as possible from the outlet of the same trench.

h. The spacing between individual tiles shall be no greater than ¼ in. Filter material shall be crushed stone (½ to 2½ in.), gravel, slag, or similar clean (no fine) material, and shall completely encase the tiles or perforated pipe. An effective barrier such as building paper or straw, shall be provided between the filter material and the backfill.

i. Avoid disarrangement and breakage of tile and barrier during backfilling. Avoid compaction or smearing of soil at sides and bottom of excavation. Heavy equipment shall not be moved over bottom of completed excavation, nor over the area during or after backfilling.

TABLE 6-15.3 — SEPTIC TANK CAPACITY

Number of Bedroom	Min. Capacity (Gallons)
2 or less	750
3	900
4	1000
each additional Br. add	250

TABLE 6-15.4 — TRENCH SIZE AND SPACING

Trench Width at Bottom (in.)	Min. Trench Spacing (ft)
12 to 18	6.0
18 to 24	6.5
24 to 20	7.0
30 to 36	7.5

615–9.7 *Absorption Beds.*

a. Use of an absorption bed with a septic tank is acceptable only when necessary because of soil and topography. Approval for its use must be obtained from the HUD field office and local health authorities.

b. If used, design and installation shall comply with the requirements of paragraphs c, d, e, h, and i of 615–9.6, for absorption fields, and the construction of the bed shall comply with Table 6–15.7.

c. The site for the bed construction should be relatively flat, with not more than 6 in. of fall in any direction within the bed area.

d. The effective absorption area (bottom area of bed only) shall be determined from Table 6–15.5 using results of percolation tests discussed above.

e. The bottom of the absorption bed shall terminate in a porous formation at least 4 ft in thickness. No bed excavation shall extend into the water table. Where ground water is encountered, the bottom of the bed shall be raised by backfilling with clean coarse sand at least 3 ft above the water table. Absorption beds constructed in filled ground are not acceptable.

f. Filter material and a surface barrier shall be provided in accordance with 615–9.6h. Backfilling over the filter and barrier shall come from the loose excavated soil (without rocks) originally removed from the bed. Avoid compaction, smearing, and heavy equipment.

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TABLE 6-15.5—SUBSURFACE ABSORPTION FIELD OR BED
(Min. bottom area per bedroom)

Absorption Time (1) (minutes per in.)	Min. Bottom Area (sq ft)
2 or less	8
3	100
4	115
5	125
10	165
15	190
30	250
45	300
60	330
Over 60 minutes is not acceptable	

Note:
(1) Percolation tests shall be performed in accordance with the procedure in Appendix D.

TABLE 6-15.6—SUBSURFACE ABSORPTION FIELD DETAILS

Items	Unit	Max.	Min.
No. of lateral trenches	—	—	2
Length of trenches	ft	100	—
Width of trenches	in.	36	12
Depth of tile lines (bottom)	in.	36	18
Slope of tile lines	in./100 ft	6	(1)
Depth of coarse material			
Under pipe	in.	—	6
Over pipe	in.	—	2
Under pipe within 10 ft of trees	in.	—	12
Size of coarse material	in.	2 1/2	1/2
Depth of backfill over coarse material	in.	—	12
Clearance from bottom of field to water table	ft	—	3

Note:
(1) Level preferred.

TABLE 6-15.7---ABSORPTION BED CONSTRUCTION DETAILS

Item	Unit	Max.	Min.
Depth of backfill over bed	in.	--	12
Depth of tile lines (bottom)	in.	36	18
Slope of tile lines	%	0.5	(1)
Depth of filter material:			
Under pipe	in.	--	6
Over pipe	in.	--	2
Total	in.	--	12
Under pipe located within 10 ft of trees	in.	--	12
Size of filter material	in.	2 1/2	1 1/2
Effluent distribution pipes:			
Number	--	--	2
Distance between multiple pipes	ft	6	--
Distance between pipe and sidewall	ft	3	--
Length of distribution line	ft	100	--
Number of tile lines	--	--	2

Note:
(1) Bottom of bed should be relatively level.

TABLE 6-15.8---SEEPAGE PITS (MIN. AREA REQUIRED)

Symbol	Character of Soil by HUD Handbook 4075.8	Wall Area Per Bedroom (Sq Ft)
GW	Well-graded gravels, gravel-sand mixtures, little or no fines	50
GP	Poorly graded gravels or gravel-sand mixtures, little or no fines	50
SW	Well-graded sands, gravelly sand, little or no fines	75
SP	Poorly graded sands or gravelly sands, little or no fines.	75
SM	Silty sand, sand-silt mixtures	125
GC	Clayey gravels, gravel-sand-clay mixtures	150
GM	Silty gravels, gravel-sand-silt mixtures	150
SC	Clayey sands, sand-clay mixtures	150
ML	Inorganic silts and very fine sands, rock flour, silty or clayey silts with slight plasticity	300
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	350
OL	Organic silts and organic silty clays of low plasticity	(1)
MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	(1)
CH	Inorganic clays of high plasticity, fat clays	(1)
OH	Organic clays of medium to high plasticity organic silts	(1)
Pt	Peat and other highly organic soils	(1)

Note:
(1) Unsuitable.

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615–9.8 *Seepage Pits.*

a. Use of seepage pits with septic tanks is acceptable only when soil conditions of topography are appropriate, and only with the approval of the HUD field office and the health authority having jurisdiction. Seepage pits are not acceptable in lime stone areas nor in localities where shallow wells are used.

b. When more than one seepage pit is used, installation may be operated in series or in parallel. If operated in series each pit shall be equipped with an inlet tee or ell. If operated in parallel, a tee, wye, or distribution box shall be used. An outlet tee or ell shall be raised to prevent scum floating into the second pit.

c. Effective absorption area of a seepage pit shall be calculated as the side area only below the inlet, exclusive of any hard pan, rock or impermeable clay soil layer. Required seepage area shall be determined from Table 6–15.8.

d. A min. depth of 4 ft of porous formation shall remain or be provided at the bottom of each pit. Pits less than 20 ft deep shall have an inside diameter of at least 4 ft. No pit excavation shall extend into the water table. Where ground water is encountered the bottom of the pit shall be backfilled with clean coarse sand at least 3 ft above the water table.

e. Pipe with tight joints shall be used in connecting the septic tank to the pit.

f. All seepage pits shall be either lined or filled with coarse stone. The lining may be brick, stone, block, or similar durable materials, laid in cement mortar above the inlet and with tight butted joints below the inlet, The annular space between the lining and the earth wall shall be filled with crushed rock or gravel.

g. Provide for each pit a 4 in. thick concrete top, equipped with a watertight concrete pumphole and cover. The top shall bear on at least 12 in. of soil around the pit, or on top of the pit wall. The top shall be not more than 18 in. below the finished grade.

616 *Electrical.*

616–1 General.

Provide an electrical system which will assure a safe and adequate source of energy for satisfactory illumination and for efficient and convenient operation of household appliances and mechanical equipment. All switches, fixtures and outlets shall operate as intended.

616–2 *Standards.*

Except as modified herein, the design, construction, installation, adjusting and labeling of all electrical equipment, accessories and appurtenances shall comply with the applicable recognized standards given in Appendices C and E.

616–3 *Electrical Installation.*

All electrical equipment shall be installed in accordance with the current National Electrical Code, NFPA 70.

616–4 Night Light.

In housing for the elderly a convenience outlet for receiving a night light shall be provided approximately 2 ft above the floor between the bed location and the bathroom.

Appendix A

Definitions

Abbreviations, terms, phrases, and words used in these Minimum Property Standards shall have the meanings given in this appendix. The following terms are defined for HUD purposes and the definitions may differ from those used in building codes and elsewhere.

Community System. A central utility system owned, operated and maintained by a private corporation or a nonprofit property owner's association.

Conductance, Thermal. The time rate of heat flow through a unit area of a material of a given thickness, per unit of temperature difference. Value is expressed in Btu/(hr x sq ft x F). (symbol C).

Condutivity, Thermal. The time rate of heat flow through a unit area of a homogenous material under the influence of a unit temperature gradient. Value is expressed in (Btu x in.)/(hr x sq ft x F). (symbol k).

Conventional Masonry Construction. unreinforced masonry that is desgined in accordance with empirical requirements and limitations, i.e. not designed in accordance with engineered masonry construction.

Court:

Inner Court. An open outdoor space enclosed on all sides by exterior walls of a building or by exterior walls and property lines on which walls are allowable.

Outer Court. An open outdoor space enclosed on at least two sides by exterior walls of a building or by exterior walls and property lines on which walls are allowable, with one side open to a street, driveway, alley, or yard.

Dwelling. A building designed or used as living quarters for one or two families.

Detached. A living unit which is completely surrounded by permanent open space.

Duplex. A detached building with two living units arranged side by side or one above the other.

End-Row. Same as semi-detached.

Row. A living unit, the walls on two opposite sides of which are party, lot line or common walls. Configurations such as quadruplexes and triplexes containing living units with two party, lot line or common walls not necessarily opposite to each other may be considered row or end-row houses.

Semi-Detached. A living unit of which one side wall is a party, lot line or common wall.

Engineered Masonry Construction. Construction that is designed based on engineering analysis, i.e. in accorance with SCPI, NCMA, and ANSI A41.2 Standard for Engineered or Reinforced Masonry.

Exit. That portion of a means of egress which provides a way of travel to the exterior.

Finish Rating. The time at which the stud, joist or core reaches an average temperature rise of 250 F or an individual temperature rise of 325 F as measured on the plane of the stud, joist or core nearest the fire in accordance with ASTM E119 test.

Habitable Room. A room designed and used in accordance with the MPS for living, sleeping, eating or cooking, or combination thereof. Bathrooms, toilet compartments, closets, halls, storage spaces, laundry and utility rooms, basement recreation rooms and similar areas are not considered habitable rooms.

Impact Insulation Class (IIC). A single-figure rating which provides an estimate of the impact sound insulating performance of a floor-ceiling assembly. It shall be determined in accordance with ASTM E492–73T Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine.

Independent Inspection Agency. Where the term "independent inspection agency" is used in these standards, the reference is to an agency which maintains a program of continuous control, testing and inspection over the quality of the product. Such an agency must conform to procedures set forth in ANSI Z34.1–59, and shall be acceptable to HUD.

Individual System. A utility system such as water or sewerage serving a single property and located on that property.

Listed and Listing. Terms referring to materials, equipment or products which have been tested to and comply with an applicable standard and which are shown in a list published by a recognized certifying agency.

Living Unit. A single residential unit providing complete, independent living facilities for one or more persons including permanent provisions for living, sleeping, eating, cooking and sanitation.

Noncombustible. As applied to a building construction material means a material no part of which will ignite, burn or release flammable vapors when subjected to fire in accordance with ASTM E136 test Noncombustibility of Elementary Materials.

Perm. The unit of measurement of the water vapor permeability of a material. Value of one perm is equal to one grain of water vapor per square foot per hour per inch of mercury vapor pressure difference.

Property. An area of ground under one legal ownership including all buildings and improvements thereon.

Public Space. Public space is a legal open space on the premises accessible to a public way or street, such as a yard, court, or open space permanently devoted to public use and abutting the premises.

Public System. A central utility owned, operated, and maintained by a municipality, county, or other unit of local government having power to tax or levy assessments.

R Thermal Resistance. A measure of ability to retard heat flow. Thermal conductance: R=1/C.

Required. Mandatory.

Shall. Indicates that which is required.

Sound Transmission Class (STC). A single-figure rating which provides an estimate of the airborne sound insulating performance of building walls and floor-ceiling assemblies. It shall be determined in accordance with ASTM E90 and ASTM E413.

Story. That portion of a building between a floor and the next floor above, or roof.

First Story (First Floor). The lowermost story which is primarily above exterior grade on one or more sides, containing at least 50 percent living accommodations or related nonresidential uses. Stories below grade used for storage, parking, mechanical equipment or other services are considered basement

stories. Related nonresidential uses include laundry space, recreation or hobby rooms, commercial use and related corridor space.

Half Story. A story finished as living accommodations located wholly or partly within the roof frame and having a floor at least half as large as the story below. Space with less than 5 ft clear headroom shall not be considered as floor area.

Top Story. The story between the uppermost floor and the ceiling or roof above.

Toilet Room. (Half Bath). Enclosed space, containing a watercloset and a lavatory.

U Overall Coefficient of Heat Transmission. The combined thermal value of all the materials in a building section, air spaces, and surface air films. U is expressed in Btu/(hr × sq ft × F).

Wall.

Common Wall. A wall separating two living units in the same real estate entity.

Firewall. A wall with qualities of fire resistance and structural stability which subdivides a building into fire areas, and which retards the spread of fire.

Lot Line Wall. A wall adjoining and parallel to the lot line used primarily by the party upon whose lot the wall is located. Lot line walls may share common foundations.

Party Wall. A wall used jointly by two parties under easement, erected upon a line separating two parcels of land, each of which is a separate real estate entity.

Appendix B—Abbreviations

AA Aluminum Association.
AAMA Architectural Aluminum Manufacturers Association.
AACA Air Conditioning Contractors Association (Formerly NESCA).
ACI American Concrete Institute.
agg Aggregate.
AGA American Gas Association.
AHA American Hardboard Association (Formerly American Board Products Association).
AHAM Association of Home Appliance Manufacturers.
AHLI American Home Lighting Institute.
AIA American Insurance Association.
AISC American Institute of Steel Construction.
AISI American Iron and Steel Institute.
AITC American Institute of Timber Construction.
AMCA Air Moving and Conditioning Association.
ANSI American National Standards Institute.
APA American Plywood Association.
ARI Air Conditioning & Refrigeration Institute.
ASCE American Society of Civil Engineers.
ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers.
ASME American Society of Mechanical Engineers.
ASTM American Society for Testing and Materials.
AWPA American Wood Preservers Association.
AWPB American Wood Preservers Bureau.
AWPI American Wood Preservers Institute.
AWS American Welding Society.
AWWA American Water Works Association.
BIA Brick Institute of America (Formerly Structural Clay Products Institute—SCPI).
BOCA Building Officials and Code Administrators, International, Inc.
BRAB Builders Research Advisory Board.
Btuh British thermal units per hour.
cf or cu ft Cubic feet.
cfm Cubic feet per minute.
CFR Code of Federal Regulations.
CISPI Cast Iron Soil Pipe Institute.
CMA Cellulose Manufacturers Association.
CPSC Consumer Product Safety Commission.
CS Commercial Standard.
CTI Ceramic Tile Institute.
cts Coats.
cy Cubic yards.
dBA Sound pressure level as measured using the A-weighted network (decibels).
dwv Drain, waste and vent.
EEA Electric Energy Association.
EEI Edison Electric Institute.
EPA Environmental Protection Agency.
ext. Exterior.
F Fahrenheit (degrees).
FHA Federal Housing Administration.
FHDA Fir and Hemlock Door Association.
fpm Feet per minute.
FS Federal Specification.
ft Feet.
ga Gauge.
gals Gallons.
galv Galvanized.
GAMA Gas Appliance Manufacturers Association.
gph/kw Gallons per hour per kilowatt.
gpm Gallons per minute.
gpsf/h Gallons per square foot per hour.
HPMA Hardwood Plywood Manufacturers Association.
hr Hour.
HUD Department of Housing and Urban Development.
HVI Home Ventilating Institute.
HYDI Hydronics Institute (See IBR).
IAPMO International Association of Plumbing and Mechanical Officials.
IBR Institute of Boiler and Radiator Manufacturers (Superseded by HYDI).
ICBO International Conference of Building Officials.
IIC Impact Insulation Class.
id Inside diameter.
in. Inches.
IPS International Pipe Standard.
int. Interior.
kw Kilowatts.
lb Pounds.
lin ft Linear feet.
LP Liquified Petroleum.
max. Maximum.
MCA or MCAA Mechanical Contractor's Association of America.
MIMA Mineral Insulation Manufacturers Association (Formerly NMWIA).
min. Minimum.
mph Miles per hour.
MPS Minimum Property Standards.
NAAMM The National Association of Architectural Metal Manufacturers.
NAHB–RF National Association of Home Builders—Research Foundation.
NBBPVI National Board of Boiler and Pressure Vessels Inspectors.
NBS National Bureau of Standards.
NCMA National Concrete Masonry Association.
NEC National Electric Code.
NECA National Electrical Contractors Association.
NEMA National Electrical Manufacturers Association.
NFPA National Forest Products Association.
NFPA National Fire Protection Association.
NOFMA–OFGR National Oak Flooring Manufacturers' Association—Official Flooring Grading Rules.
NPA National Particleboard Association.
NRCA National Roofing Contractors Association.
NRMCA National Ready-Mixed Concrete Association.
NSF National Sanitation Foundation.
NTMA National Terrazzo & Mosaic Association.
NWMA National Woodwork Manufacturers Association.
oc On center.
od Outside diameter.
oz Ounces.
PCA Portland Cement Association.
PCI Prestressed Concrete Institute.
PS Product Standard.
ppm Parts per million.
psf Pounds per square foot.
psi Pounds per square inch.
pvc Polyvinyl chloride.
SBI Steel Boiler Institute—Division of Hydronics Institute.
SCACM Southern California Association of Cabinets Manufacturers.
SCS Soil Conservation Service.
SEAOC Structural Engineers Association of California.
SFPA Southern Forest Products Association.
SGCC Safety Glazing Certification Council.
SI International Standard.
SJI Steel Joist Institute.
SMACNA Sheet-Metal and Air Conditioning Contractors National Association, Inc.
SPMA Sump Pump Manufacturers Association.
sq yd Square yard.
SSBC Southern Standard Building Code.
STC Sound Transmission Class.
t & g or T & G Tongue and groove.
TCA Tile Council of America.
TECO Timber Engineering Company.
TPI Truss Plate Institute.
U Coefficient of thermal transmission Btu/(hour) (square foot) (F_{inside}—$F_{outside}$).
UBC Uniform Building Code by ICBO.
UL Underwriters' Laboratories, Inc.
UM Use of Materials Bulletin.
USDA United States Department of Agriculture.
vcp Vitrified clay pipe.
wi Wrought iron.
WM Western Wood Moulding and Millwork Producers.
WQA Water Quality Association (Formerly Water Conditioning Foundation).

Appendix C

Material Standards

Materials listed in Appendix C are a partial listing of materials considered to meet the min. requirements of the MPS. For other

acceptable materials, see 500, 501, 513 and Appendix F.

502 *Site.*

Site Improvements.....FS RR–H–1070

Bituminous Work—Asphalt Institute Standards

Drainage—Culvert and Pipes:

Clay Drain Tile..... ASTM C 4

Clay Pipe, Extra Strength and Standard Strength..... ASTM C 700

Perforated Clay Pipe, Standard Strength and Extra Strength...ASTM C 700

Pipe, Clay (Vitrified Fittings and Perforated Pipe).....FS–SS–P–361

Concrete Culvert, Storm-Drain and Sewer Pipe.....ASTM C 76

Concrete Drain Tile..... ASTM C 412

Concrete Sewer, Storm Drain and Culvert Pipe.....ASTM C 14

Homogenized Bituminous Fiber Drain and Sewer Pipe.....ASTM D 1861

Perforated Concrete Pipe.....ASTM C 444

Pipe, Corrugated (Iron or Steel, Zinc Coated).....FS WW–P–405

Porous Concrete Pipe..... ASTM C 654

Reinforced Concrete D-Load Culvert Storm Drain and Sewer Pipe.....ASTM C 655

Premolded Joint Filler (Non-extruding).....ASTM D 544

Poured Joint Filler..... FS SS–F–336

Chain Link Fence, Type A.... FS RR–F–191

503 *Concrete.*

Materials Chapters of:

Building Code Requirements for Reinforced Concrete.....ACI 318

Specifications for Structural Concrete in Buildings.....ACI 301

Cementitious Materials:

Portland Cement, Type I, II, III, or V..... ASTM C 150

Blended Hydraulic Cements...ASTM C [redacted]

Gypsum Plasters, Calcined Gypsum..... ASTM C 28

Aggregate:

Normal Weight..... ASTM C 33

Light Weight.....ASTM C 330

Lightweight Aggregate for Insulating Concrete.....ASTM C 332

Gypsum Plaster.....ASTM C 35

Reinforcement:

Cold-drawn Steel Wire.....ASTM A 82

Deformed Billet Steel..... ASTM A 615

Rail-steel Deformed Bars..... ASTM A 616

Axle-steel Deformed Bars..... ASTM A 617

Bar and Rod Mats..... ASTM A 184

Prestressed Steel Strand.....ASTM A 416

Prestressed Steel Wire.....ASTM A 421

Admixtures:

Air Entraining..... ASTM C 260

Fly Ash—Pozzolan (Raw or Calcined).....ASTM C 618

Chemical..... ASTM C 494

Ready-mixed Concrete.....ASTM C 94

Gypsum Concrete.....ASTM C 317

Precast Reinforced Gypsum Concrete Slabs.....ASTM C 377

Expansion Joint Materials...FS HH–F–341E, ASTM D 994 or D 1751, D 1752

Penetration Resistance of Hardened Concrete.....ASTM C 803

504 *Masonry.*

Brick Masonry—SCPI, Building Code Requirements for Engineered Brick Masonry (Section 2).

Concrete Masonry—NCMA, Specifications for the Design and Construction of Load Bearing Concrete Masonry (Chapter 2).

Cementitious Materials (1):

Portland Cement.....ASTM C 150

Portland Cement, Air Entraining...ASTM C 175

Portland Blast Furnace Slab Cement..... ASTM C 205

Hydrated Lime, Type S..... ASTM C 207

Quick Lime.....ASTM C 5

Gypsum..... ASTM C 22

Masonry Cement..... ASTM C 91

Note (1):

Cementitious materials other than allowed by ASTM C 270 or listed herein are considered nonstandard materials and shall be submitted for review before use in accordance with 500–3. Chemical analysis and tests for compressive strength (ASTM C 270) and for bond strength (ASTM E 149) will be required.

Aggregate..... ASTM C 144

Mortar and Grout:

Reinforced Masonry..... ASTM C 476

Non-reinforced Masonry Types M, S, N, or O.....ASTM C 270

Other Mortars.....ASTM E 447

Building Brick:

Clay Brick..... ASTM C 62

Facing Brick.....ASTM C 216

Sand Lime Brick.....ASTM C 73

Fire Brick....FS HH–R–191 or ASTM C 106

Sewer and Manhole Brick..... ASTM C 32

Paving Brick.....ASTM C 7

Structural Clay Tile:

Load Bearing...FS SS–T–341 or ASTM C [redacted]

Glazed Structural Clay Tile...ASTM C [redacted]

Non-Load Bearing...FS SS–T–351 or ASTM C 56

Structural Clay (facing).....ASTM C 212

Hollow Masonry Units Made from Clay or Shale.....ASTM C 652

Concrete Masonry:

Hollow Units..... ASTM C 90

Hollow Non-load Bearing.....ASTM C 129

Solid Units..... ASTM C 145

Concrete Brick—Solid Core Split Block..... ASTM C 55

Cast Stone..... ACI 704

Miscellaneous Masonry:

Clay Flue Lining.....ASTM C 315

Ceramic Glazed Facing, Tile or Brick.....ASTM C 126

Structural Clay Floor Tile...FS SS–T–321 or ASTM C 57

Sewer Brick... FS SS–B–391 or ASTM C 32

Ceramic Tile..... TCA 137.1

Concrete Masonry Catch Basins, Manholes.....ASTM C 139

Precast Concrete Culvert, Storm Drain, Sewer Pipe.....ASTM C 76

Drain Tile..... ASTM C 4, or ASTM C 412

Cold-drawn Steel Wire.....ASTM A 82

Screen Tile.....ASTM C 530

Gypsum Tile or Block.....ASTM C 52

505 *Metals.*

Aluminum—AA, Aluminum Construction Manual.

Aluminum—See chemical composition in standards.

Carbon Steel Forgings.....ASTM A 235

Alloy Steel Forgings..... ASTM A 237

Mild- to Medium-Strength Carbon-Steel Casting for General Application.....ASTM A 27

High Strength Steel Castings..... ASTM A 148

Structural Steel..... ASTM A 36

High Strength, Low Alloy Steel....ASTM A 242

High Strength Structural Steel.....ASTM A 440

High Strength, Low Alloy Steel....ASTM A 441

Structural Steel, 42,000 psi..... ASTM A 529

High Strength, Low Alloy Steel....ASTM A 572

High Strength, Low Alloy Steel....ASTM A 588

Welded and Seamless Steel Pipe...ASTM A [redacted]

Cold-Formed Welded and Seamless Steel Tubing..... ASTM A 500

Hot-Formed Selded and Seamless Steel Tubing..... ASTM A 501

Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing..... ASTM A 618

Flat-Rolled Carbon Sheets of Structural Quality..... ASTM A 245

High Strength Cold-Rolled Steel Sheets and Strip..... ASTM A 374

High Strength Hot-Rolled Steel Sheets and Strip..... ASTM A 375

Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process, Physical (Structural) Quality..... ASTM A 446

Hot Rolled Carbon Steel Sheets and Strip..... ASTM A 570

Steel Hot-Rolled and Cold-Rolled Sheet and Strip.....ASTM A 606

Steel Sheet and Strip Hot-Rolled and Cold-Rolled..... ASTM A 607

Cold-Rolled Steel Sheet Carbon Structural.....ASTM A 611

Tempered Alloy Steel Plate..... ASTM A 514

Steel Structural Rivets..... ASTM A 502

Low Carbon Steel Fasteners..... ASTM A 307

High-Strength Bolts for Structural Steel Joints, Including Suitable Nuts and Plain Hardened Washers..... ASTM A 325

Quenched and Tempered Steel Bolts...ASTM A 449

Quenched and Tempered Steel Bolts...ASTM A 490

Steel Welding—AWS Structural Welding Code..... AWS D 1.1

Corrosion-resisting, Chromium-Nickel Steel..... ASTM A 167

Stainless and Heat Resisting Steel...ASTM A 412

Metal Curtain Walls...NAAMM Specification Manual

506 *Carpentry.*

Dimension, Board Lumber and Timbers.....PS–20

Softwood Plywood..... PS–1

Structural Glued Laminated Timber.....PS–56

Adhesives Used in Nonstructural Glued Lumber Products..... ASTM D 3110

Pressure Treated Lumber and Plywood:

Above ground use:

Water Borne Preservatives.... AWPB LP–2

Light Petroleum Solvent-penta Solution..... AWPB LP–3

Volatile Petroleum Solvent-penta Solution..... AWPB LP–4

Ground contact use:

Water Borne Preservatives...AWPB LP– [redacted]

Light Petroleum Solvent-penta Solution..... AWPB LP–33

Volatile Petroleum Solvent-penta Solution..... AWPB LP–44

Basic Hardboard.....ANSI/PS–58

Hardboard Siding.....ANSI/PS–60

Vacuum Treated Exterior Softwood Millwork....NWMA IS 4
Non-pressure Treated Millwork... NWMA IS 4
Fire Retardant Pressure Treatment:
Lumber....AWPA C–20
Plywood...AWPA C–27, ASTM E 84, ASTM D 2898
Gypsum Sheathing...FS SS–L–30 or ASTM C 79
Fiberboard Sheathing...FS LLL–I–535 or Class E, ASTM C 208
Cellulosic Fiber Insulating Board.....PS 57
Application of Structural Insulating Board (Fiberboard) Sheathing....ASTM C 846
Mat-Formed Wood Particleboard...ANSI A208.1
Sheathing Paper...FS UUB–790, Grade D or ASTM D 226
Nails....FS FF–N–105 or CS–263
Vinyl Wrapped Interior Moulding and Millwork....WM 2–73, Section 4
Staples....FHA UM–25
Screws....FS FF–S–111
Bolts....FS FF–B–561 or FF–B–571

507 *Thermal and Moisture Protection.*

507–1 Waterproofing and Dampproofing.
Asphalt....FS SS–A–666 or ASTM D 449
Felt, Asphalt-saturated....ASTM D 226
Felt, Coal-tar-saturated....ASTM D 227
Coal-tar Pitch.....FS R–P–381 or ASTM D 450
Roll Roofing, 55 lb Smooth Surface...FS SS–R–501 or ASTM D 224
Clay Drain Tile....ASTM C 4
Perforated Clay Pipe....ASTM C 700
Concrete Drain Tile....ASTM C 412
Pipe, Clay (Vitrified Fittings and Perforated Pipe)....FS SS–P–361
Perforated Asbestos-Cement Drain Pipe....FS SS–P–340 or ASTM C 508
Perforated Corrugated Iron and Steel Drain Pipe....FS WW–P–405
Bituminous Fiber Drain Pipe...FS SS–P–1540, ASTM D 1861, ASTM D 1862, ASTM D 2311, ASTM D 2316, ASTM C 2417
Acrylonitrile-Butadiene-Styrene Plastic Drain Pipe.....ASTM D 2661, ASTM D 2751
Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings....ASTM D 2729
Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings....ASTM D 2665
Corrugated Polyethylene Tubing...ASTM F 405, ASTM D 2321

507–2 Vapor Barriers.
Test for Water Vapor Transmission—Thick Material....ASTM C 355
Test for Water Vapor Transmission—Thin Material....ASTM E 96
Under Concrete and as Ground Cover....ASTM E 154
Polyethylene Plastic Sheets...FS L–P–512, ASTM D 2103
Vinyl Chloride Plastic Sheets...FS–L–P–375, ASTM D 1593

507–3 Building Insulation.
Cork Board....FS HH–I–525
Cellular Glass....FS HH–I–551
Cellulose, Vegetable or Wood Fiber...FS HH–I–515
Expanded Polystyrene Insulation Board....FS HH–I–524
Fiberboard...FS LLL–I–535, Class C or E or ASTM C 209
Insulation Board (Urethane).....FS HH–I–530
Mineral Fiber, Board (Roof).....FS HH–I–526
Mineral Fiber, Insulation Blanket...FS HH–I–521
Mineral Fiber, Pneumatic or Poured...FS HH–I–1030
Perimeter Insulation...FS HH–I–524, Type II, FS HH–I–558, Form A, Class I or II
Reflective, Thermal....FS HH–I–1252
Cellulosic Fiber Insulating Board....PS–57
Application of Structural Insulating Board (Fiberboard) Sheathing...ASTM C 846
Vermiculite (used as masonry wall filler)....FS HH–I–585
Vermiculite (for other uses) ASTM C 516
Perlite....FS HH–I–574 or ASTM C 549
Urea-Based Foamed in Place....UM 74

507–5 Sheet Metal.
Aluminum—Aluminum Sheet Metal in Building Construction, AA
Copper.....F SQQ–C–567, ASTM B 370
Galvanized Steel or Iron...ASTM A 361 or ASTM A 525
High Strength Low Alloy Steel.....ASTM A 606
Sheet Lead....FS–QQ–L–775
Stainless Steel...Type 302 or 304, ASTM A 167
Terne Plate....FSQQ–T–191, QQ–T–201
Zinc Copper Alloy....FS QQ–Z–100

507–6 Caulking and Sealants.
Elastomeric Type; Multi-Compound...FS TT–S–227
Elastomeric Type; Single-Compound...FS TT–S–230
Oil and Resin Base Type....FS TT–C–598
Silicone Rubber Base....FS TT–S–1543
Butle Rubber Base; Single-Compound...FS TT–S–1657
NAAMM Specification for Non-skinning Bulk Compounds.
NAAM Specification for Non-skinning Non-resilient Preformed Compounds.
NAAMM Specification for Non-skinning Resilient Preformed Compounds.
Celluar Neoprene....ASTM C 509
NAAM Specifications for Rubber-like Gasket Materials.
NAAMM Specifications for Plastic Gasket Materials.

508 *Doors, Windows, Glazing Panels*
Metal Doors and Frames:
Interior Steel Doors and Frames (flush)....PS–4
1¾ in. thick Steel Doors and Frames....CS–242
Aluminum Storm Doors.....ANSI A134.4
Wood Doors and Frames:
Hardwood, Hardboard and Plastic Faced Flush Doors....NWMA IS–1
Hinged Interior Wood Door Units....PS–32
Ponderosa Pine Doors....NWMA IS–5
Douglas Fir, Sitka Spruce and Western Hemlock Doors....FHDA–4
Wood Flush Doors....NWMA IS–1
Wood Storm Doors....NWMA IS–5
Exterior Wood Door Frames....WM 3
Special Doors:
Aluminum Sliding Glass Doors...ANSI A134.2
Wood Sliding Patio Doors.....NWMA IS–3
Metal Windows and Frames:
Aluminum Prime Windows...ANSI A134.1
Alumimum Combination Storm Windows....ANSI A134.3
Wood Windows and Frames:
Wood Window Units...ANSI A200.1 Class A or B
Hardware:
Lockset....ANSI A156.2
Wire Fabric (Insect Screening)...FS RR–W–365 (Amend. 1967)
Screening, Insect, Non-metallic...FS L–S–125
Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Fiber Yarn....ANSI/ASTM D 3656
Glass and Other Glazing Panels:
Acrylic Plastic Sheets for Glazing....FHA UM–58
Glass....FS DD–G–451
Safety Glass and Other Safety Glazing Panel Materials...CPSC 16 CFR Part 1201
Safety Glazing Material Used in Buildings...SGCC Certified Products Directory
Tempered Glass....FSDD–G–1403
Voluntary Standards and Tests of Thermal Performance of Residential Insulating Windows and Sliding Glass Doors.....AAMA 1502.6

509 *Finish Materials.*

509–2 Exterior Wall Finishes.
Aluminum....AAMA 1402.2
Asbestos-cement...FS SS–S–346, ASTM C 220, ASTM C 221, ASTM C 223
Building Paper, Grade D.....FS UU–B–790
Fiberboard Shingle Backer...ASTM C 208, Class G
Basic Hardboard.....PS–58, ANSI A135.4
Hardboard Siding.....PS–60, ANSI A135.6
Mat-Formed Wood Particleboard...ANSI A208.1, Grade 2–M–1
Plywood....PS–1 or PS–51
Rigid PVC (polyvinyl chloride)....PS–55
Textured Plywood Panel Siding.....UM–64
Stucco (exterior plaster)....ANSI A42.2

509–3 Roof Coverings
Asbestos-cement Shingles...ASTM C 222 or FS SS–S–291
Asphalt Shingles A, B and C Fire Rating...ASTM D 225, FS SS–S–1534, Class C
Asphalt Shingles, Glass Fiber Mat, A and B Fire Rating....ASTM D 3462
Underlayment:
Asphalt Saturated Felt...ASTM D 226, FS HH–R–595
Asphalt-Saturated-Asbestos Felt...ASTM D 250, FS HH–R–590
Building Paper-Type 1 Graded....FS UU–B–790
Concrete Roofing Tile....FHA UM–17
Built-up Roofing:
Aggregate....ASTM D 1863
Asphalt..... ASTM D 312 or FS SS–A–666
Asphalt-saturated Asbestos Felt...ASTM D 250, ASTM D 655 or FS HH–R–590
Asphalt-saturated Felt...ASTM D 226 or FS HH–R–595
Bituminous-saturated Cotton...ASTM D 173 or FS SS–C–450
Coal-tar-saturated Felt...ASTM D 277 or FS HH–R–595
Coal-tar-pitch...Type A ASTM D 450 Type 1, FS–R–P–381
Asphalt-prepared Felt, Mineral surface....FS SS–R–630
Wide Salvage Roll Roofing... ASTM D 371
Elastomeric CSPE Sheets.....FHA UM–62

509–4 Interior Wall and Ceiling Finish
Accoustic Tile.....FS SS–S–118
Ceramic Wall Tile.....TCA 137.1
Portland Cement.....ASTM C 150, Type 1
Hydrated Lime...ASTM C 206, C 207, Type S
Sand.....ASTM C 144
Metal Lath.....ANSI A42
Organic Adhesives.....ANSI A136.1
Dry-set Portland Cement Mortar...ANSI A118.1
Fiberboard ASTM C 208, Class D, FS–LLL–I–535, Class D
Gypsum Veneer Base.....ASTM C 588
Gypsum Veneer Plaster.....ASTM C 587
Gypsum Wall Board...ASTM C 36 or FS SS–L–30
Water-resistant backing board...ASTM C 630
Nails.....ASTM C 514
Laminating Adhesives.....ASTM C 475
Standard Specification for the Application and Finishing of Gypsum Board ASTM C 840
Hardwood and Decorative Plywood.....PS–51
High Pressure Laminated Plastic Panel.....NEMA LD–1
Prefinished Hardboard Paneling PS–59 ANSI A135.5
Basic Hardboard.....PS–58
Lath and Plaster:
Metal Lath.....ASTM C 841
Gypsum Lath... ASTM C 37 or FS SS–L–30
Gypsum Plaster...ASTM C 28 or FS SS–P–402
Inorganic Aggregates.....ASTM C 35
Lime.....ASTM C 6 or C 206
Keene's Cement...ASTMC 61 or FS SS–C–101

509–5 Finish Flooring-Rigid.
Ceramic Tile.....TCA 137.1
Adhesive (organic).....ANSI A136.1
Dry-set Portland Cement Mortar...ANSI A118.1
Expoxy Adhesive and Grout...ANSI A118.3
Terrazzo (NTMA Specs and Technical Data).
Wood:
Block, Slat.....PS–27
Block, Laminated.....HPMA–LF–71
Strip Oak Flooring...NOFMA–OFGR/Vol. 1, No. 1

509–6 Resilient Flooring.
Asphalt Tile (Type I)—Vinyl Tile (Type III)—Rubber Tile (Type II)—Vinyl-asbestos Tile (Type IV)...FS SS–T–312
Linoleum.....FS LLL–F–1238
Rotovinyls (Unvilled Vinyl Sheet)...FS L–F–001641
Seamless Coating System.....FS TT–C–1685
Backed Vinyl Plastic Sheet or Tile (Grade C).....FS L–F–475
Homogeneous Vinyl Sheet.....FS L–F–00450
Underlayment:
Basic Hardboard.....PS–58, ANSI A135.4
Particleboard (Grade 1–M1)...ANSI A208.1
Plywood.....PS–1

509–8 Wall Coverings.
Vinyl-coated Wall Covering....FS CCC–W–408

509–9 Other Finishes.
Carpeting and Cushioning.....FHA UM–44
Bonded Urethane Carpet Cushion...FHA UM–37

510 Specialties.
Chimneys, Fireplaces and Venting Systems.....NFPA 211
Fireplace Stoves.....ANSI/UL737
Factory-Built Fireplaces.....UL127

511 *Equipment.*
Minimum Construction Performance Standards for Kitchen Cabinets...ANSI A161.1

515 *Mechanical.*

515–2 *Mechanical Ventilation.*
Ventilation.....HVI-Air Flow Test, AMCA–210
Fan Noise Rating...HVI-Sound Test, AMCA–300

516–3 Heating.
Air Duct, Insulated.....NFPA 90B
Furnaces:
Oil.....ANSI/UL727 and 730
Gas.....AGA listed
Electric.....ANSI/UL573, NFPA–70
Solid Fuel Type Room Heaters.....UL1482
Fireplace Stoves.....ANSI/UL737
Boilers (Steam & Hot Water):
Oil...ASME, MCA, SBI, IBR, ANSI/UL726 and 296
Gas.....ASME, MCA, SBI, AGA, IBR
Electric.....ASME, SBI
Radiation:
Baseboard.....IBR rated
Finned Tube.....IBR rated
Electric.....ANSI/UL1042, NEMA
Fuel Tanks.....ANSI/UL58

515–4 Cooling.
A/C Central.....ARI 210, ANSI/UL465
Room Units.....ANSI/UL484, ANSI Z234.1
Sound Rating.....ARI 270
Heat Pump.....ARI 240, ANSI/UL559

515–5 Plumbing.
ABS DWV.....FHA UM–79
ABS Pipe.....FHA UM–78
Cast Iron Soil Pipe...ASTM A 74, C564, CISPI HS–72, CISPI HSN–72.
Cast Iron Water Pipe...AWWA 106, AWWA 108,
Clay Pipe...ASTM C 700, ASTM C 425, ASTM C 594
Copper Drainage Tube...ANSI H23.6, ASTM B 306
Copper Water Tube and Pipe K, L & M.....ANSI H23.1, ASTM B 88
Welded Brass Tube.....ASTM B 587
CPVC Pipe.....FHA UM–76
Galvanized Steel Threaded Pipe...FS WW–P–400
Hubless C.I. Pipe.....FHA UM–77
Patented Joint for Use with Hubless C.I. Pipe.....CISPI 310
Plumbing Fixtures...FS WW–P–541, ANSI A112
Slip-Resistant Bathing Facilities...ASTM F 462
Polybutylene Water Distribution Pipe...FHA UM–76
PE Pipe.....FHA UM–78
PVC DWV.....FHA UM–79
PVC Pipe.....FHA UM–78
PVC Thin Wall.....ASTM D 2949
Stainless Steel—Grade TP–409....ASTM A 268
ABS DWV.....ASTM F 628

515–6 Domestic Water Heaters.
Oil.....ANSI/UL732
Gas.....AGA listed
Electric.....ANSI/UL174

515–7 Special Piping Systems.
Gas Piping.....NFPA 54 and 58

515–8 Water Supply System.
Water Softeners.....WQA S–100
Water Filters.....WQA S–200
Community Water Systems:
Minimum Design Standards for Community Water Supply Systems.....HUD Handbook 4940.2

515–9 SEWAGE DISPOSAL SYSTEM
Community Sewage Systems:
Minimum Design Standards for Community Sewerage Systems...HUD Handbook 4940.3
Tanks, Septic, Bituminous-Coated Metal.....ANSI/UL70

516 *Electrical.*
All Electrical Equipment (Wiring, Lighting, Appliances, Etc.)...NEC and ANSI/UL AHLI Standards

Appendix D

Test Procedures and Performance Criteria

Appendix D is a partial list of the testing procedures and performance criteria required by the Minimum Property Standards.

500 *General.*

A Wall Assemblies and Sheathing Materials—Resistance to Racking.

A–1 *Test Procedures.* Test of Walls shall be conducted in accordance with ASTM E 72, "Standard Methods of Conducting Strength Tests of Panels for Building Construction." Panel size shall be 8 ft by 8 ft.

A–2 *Performance Criteria.* The following criteria shall apply:

a. *Dry Tests.*
Load increments—400 lb.
Maximum load—5,200 lb or 0.65 kips/ft.
At load of—1,200 lb average total deflection 0.20 in. Residual deflection 0.10.
At load of—2,400 lb average total deflection 0.60 in. Residual deflection 0.30.

b. *Wet Tests.*
Load increments—400 lb.
Maximum load—4,000 lb or 0.50 kips/ft.
At load of—1,200 lb average total deflection 0.28 in. Residual deflection 0.14 in.
At load of—2,400 lb average total deflection 0.80 in. Residual deflection 0.40.

508 *Doors, Windows and Glazing.*

A Windows and Sliding Glass Doors—Air Infiltration.

A–1 *Test Procedure.* Air leakage shall be tested in accordance with ASTM E 283.

A–2 *Performance Criteria.*

a. When tested at a static air pressure of 1.567 psf, the rate of air leakage will not exceed ½ cfm per ft of crack length. Air leakage for jalousie windows is not to exceed 1½ cfm per sq ft of total ventilating area. Air leakage for sliding glass doors is not to exceed 1 cfm per sq ft of overall frame dimension.

b. In areas subject to winds (90 mph and over) the performance requirement for sliding glass doors may be increased at the discretion of the HUD field office so that the air leakage will not exceed ½ cfm per sq ft of overall frame dimension.

B Windows and Sliding Glass Doors—Water Resistance.

B–1 *Test Procedure.* Water infiltration shall be tested in accordance with ASTM E 331.

B–2 *Performance Criteria.*

a. Minimum Performance—No water shall pass the interior face of the unit when tested at a static pressure of 2.86 psf with water applied at the rate of 5.0 U.S. gal per sq ft per hour for a time period of 15 minutes.

b. In areas subject to wind driven rain (90 mph and over) the static pressure in (a) may be raised to 6.24 psf at the discretion of the HUD field office.

C Windows and Sliding Glass Doors—Physical Load.

C–1 *Test Procedure.* Physical load tests shall be conducted in accordance with ASTM E 330.

C–2 *Performance Criteria.*

a. Minimum Performance.

(1) Under a uniform load of 10 psf applied to surface of unit, except jalousie windows and sliding glass doors, max. deflection of any member shall not exceed 1/175 of its span.

(2) Under a uniform load of 20 psf applied for 10 seconds to the ext., then a uniform load of 10 psf applied to the int. for 10 seconds, there shall be no glass breakage, damage to hardware or residual deflection.

b. In areas subject to winds 90 mph and over, the uniform loads, shown in a. (2) may be increased to 40 psf ext. and 20 psf int. loadings, at the discretion of the HUD field office.

615–5 *Plumbing.*

Precast Terrazzo Concrete Shower Receptors for Use Without Shower Pans

A General.

Receptors shall be of concrete with no voids. Top surface aggregate shall contain sufficient marble chips to assure a finished surface of at least 65 percent marble. (See Fig. 1 for details.)

Metal reenforcing band, if used, and the drain shall be integrally cast with the concrete.

Top surface shall be ground and polished with a 100 grit or smoother stone. Bottom surface shall be steel troweled.

All surface voids shall be filled with wet cement and polished or troweled to match adjoining surfaces.

All top surfaces shall be treated with a synthetic resin type terrazzo sealer to prevent staining. Sealer shall be applied in accordance with manufacturer's instructions.

Receptor shall be labeled to permit identification of manufacturer and model of unit. Label shall be placed so that it is visible after the receptor is installed.

B Test Procedure and Performance Criteria.

B–1 *Specimen.* Two 36 in. x 36 in. receptors which will have an age of 28 days from the date of manufacture to the date the following tests are applied shall be selected from the manufacturer's stock.

B–2 *Visual Examination Test.*

a. Method of Testing. Receptor shall be examined for over-all general appearance and shrinkage cracks.

b. Performance Criteria. The examination shall show no evidence of surface defects or shrinkage cracks.

B–3 *Leakage Test.*

a. Method of Testing. One receptor shall be filled with water to a level of ½ in. below the top of the shoulder and allowed to stand for 7 days at room temperature. Water level shall be maintained within approximately ¼ in. of the initial level.

b. Performance Criteria. The bottom surface of the receptor shall show no evidence of moisture at the end of the 7 days period.

B–4 *1,000 Pounds Concentrated Load Test.*

a. Method of Testing. Receptor shall be supported at two diagonally opposite corners with the line of support 3 in. from each corner to provide a bearing length of approximately 6 in. at each support. To permit observation of the bottom of the receptor, the supports should be at least 30 in. above the platen of the load testing machine. Fill receptor with water before load is applied. See Drawing No. 1 for details of test set-up and method of applying load.

b. Performance Criteria. The receptor shall show no evidence of cracking and/or leaking during any part of the 1,000 lb load application.

Continue application of the load until first crack or leak appears. Record the amount of load at appearance of first crack or leak.

B–5 *Water Absorption Test.*

a. Method of Testing. Obtain a segment of the receptor cracked during the above load test. The segment shall be approximately twenty-five (25) sq in. in surface area and shall be taken from any part of the receptor floor having a thickness of less than two (2) in.

Dry the segment in a ventilated oven at a temperature of 110° C for 72 hrs. Cool to room temperature and weigh the segment.

Submerge the segment in clean tap water and allow to soak for 24 hrs.

At the end of the soaking period, remove the segment from the water, blot with a damp towel and weigh segment immediately after blotting.

Report the water absorbed as a percentage of the dry weight.

b. Performance Criteria. Water absorbed shall not exceed 7 percent of the segment dry weight.

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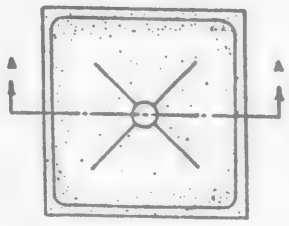
Note: When metal band is not used; minimum shoulder height shall be 6"; the height may be reduced to a minimum of 5" at the threshold.



Plan of Receptor

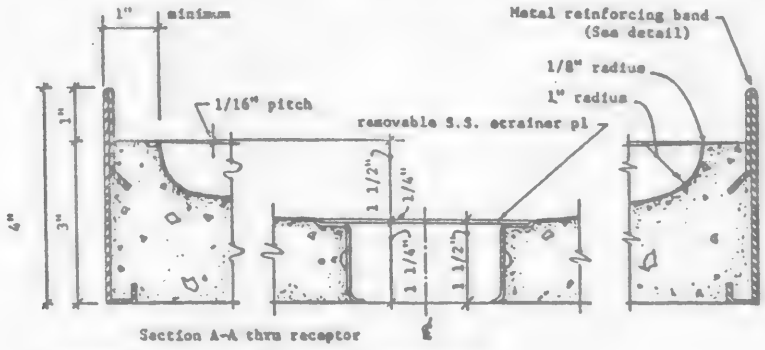


Fig. 1 PRECAST CONCRETE SHOWER RECEPTOR

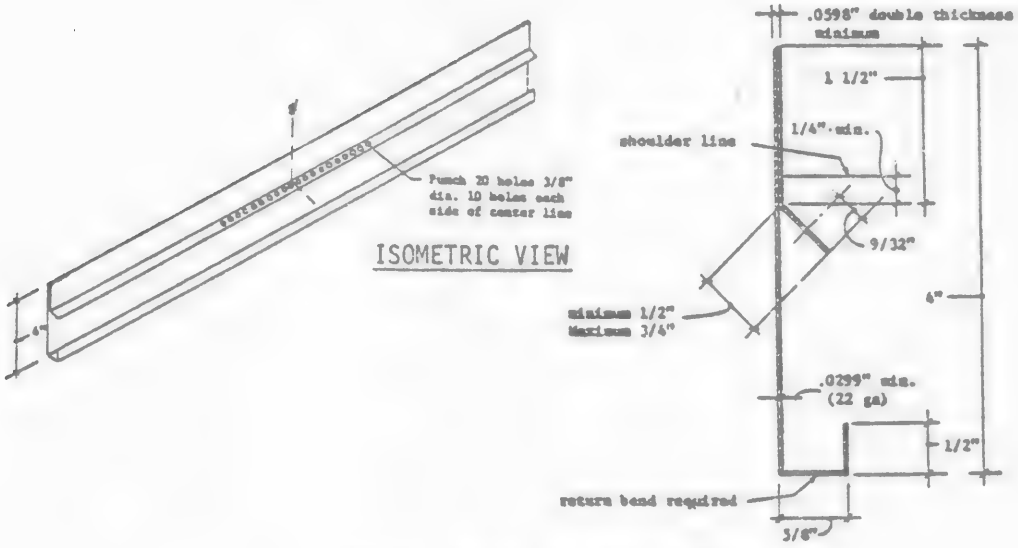
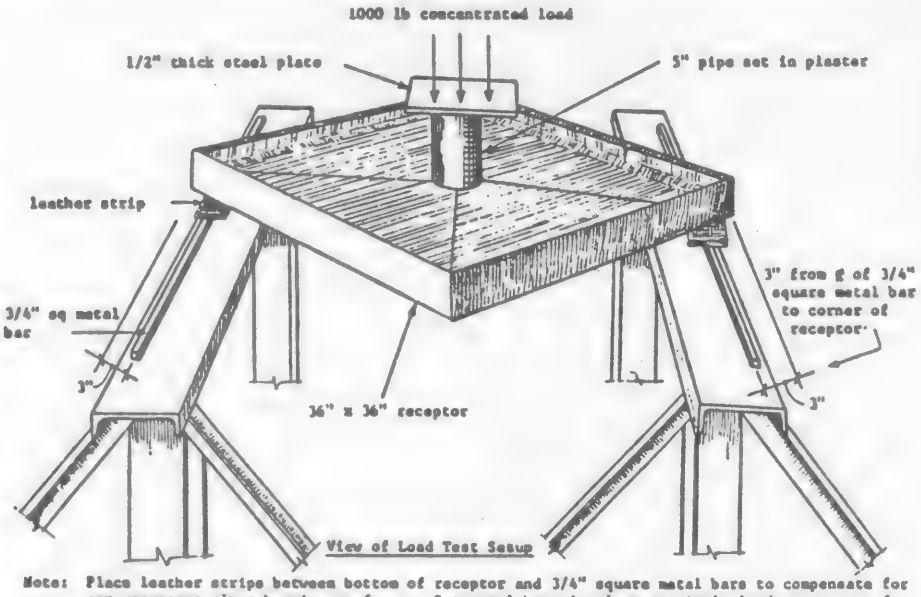


Fig. 2 DETAIL: METAL REINFORCING BAND


1000 lb concentrated load
1/2" thick steel plate
5" pipe set in plaster
leather strip
3/4" sq metal bar
3"
3" from ℄ of 3/4" square metal bar to corner of receptor
3"
36" x 36" receptor
View of Load Test Setup

Note: Place leather strips between bottom of receptor and 3/4" square metal bars to compensate for any unevenness along bearing surface. Set metal bars in plaster. Apply load at a rate of approximately 100 pounds per minute.

Fig. 3

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615–5 *Plumbing.*

Test Procedure and Performance Criteria of Materials for Use as Shower Pans

A General.

All of the following requirements apply to materials from which shower pans are fabricated.

A–1 *Hydrostatic Pressure Test*—According to Section C.

A–2 *Alkali Resistance Test*—According to Section D.

A–3 *Micro-organism Resistance Test*—According to Section E.

A–4 *Strength and Toughness Tests*—According to Section F.

These tests include:

a. *Puncture Resistance Test* according to Section F, par. 1.

b. *Indentation Resistance Test* according to Section F, par. 2.

c. *Folding Resistance Test* according to section F, par. 3.

B Sampling and Rejection Procedures.

B–1 *Sampling.* The material from which test units are to be taken shall be selected at random from regular production stock. In each roll, or group of sheets thus selected, test units comprised of a required number of specimens shall be taken from a portion not including the first or last foot of the rolls; or in the case of flat sheets not including portions within 6 in. of edges or corners.

B–2 *Rejection procedures.* If two or more specimens required for any one test unit fail to meet a particular requirement, the material shall be rejected. If only one specimen in a test unit fails to meet a particular requirement, another complete test unit of specimens of the material from the same roll, or sheet shall be subjected to the same test. If one or more specimens fail in the repeat test, the material shall be rejected.

C Hydrostatic Pressure Test.

This test is intended to determine the ability of the shower pan material to withstand water pressure without leaking.

C–1 *Specimens.* Each test unit shall consist of three specimens of flat material 3 in. x 3 in. selected in accordance with B–1.

C–2 *Apparatus.* The apparatus, described in ASTM, Designation D583 known as the American Association of Textile Chemists and colorists specimen holder for hydrostatic pressure test, shall consist essentially of a pressure tube connected to a specimen holder. The inner diameter of the pressure tube shall be 2 in. and the outer diameter 3 in., with a means for introducing water from below the specimen. An extension tube shall be connected to permit a water head of 2 ft with a cutoff valve or other suitable device at the water inlet to the pressure tube for isolating the sample until the desired head is reached.

C–3 *Procedure.* Clamp the test specimen face down in the holder, which has been previously filled with water; the face being that surface which is intended to be installed toward the shower receptor. Take care to avoid trapped air between the specimen and the water. This is done by filling the holder with water and sliding the specimen onto the holder in direct contact with the water after having used a piece of transparent material for practice and for becoming familiar with the technique.

C–4 *Performance Criteria.* Record the time to the first sight of water penetration under a 2 ft head. Observations shall be made at ten-minute intervals for the first hour, and at hourly intervals for the succeeding seven hrs after which the specimen shall be left under hydrostatic pressure for forty hrs and again examined.

Evidence of wetness on top of the material, or the formation of a droplet, are both considered as visible water penetration and require rejection of the material.

D Alkali Resistance Test.

This test is intended to indicate the effect of hot alkali solutions on the shower pan materials.

D–1 *Specimens.* These shall be as in Section C–1.

D–2 *Procedure.*

a. Make a solution by dissolving 5.0 grams of reagent grade sodium hydroxide and 5.0 grams of reagent grade potassium hydroxide in one liter of distilled water in a beaker. The solution shall be maintained at a temperature of 150 F. (66 C) measured in the solution.

b. Each specimen shall be immersed in its own individual beaker of solution prepared as in D–2a. The term of immersion shall be for 72 hrs, and the solution shall be completely changed every 24 hrs. Before immersion of a specimen in the new solution, the solution shall be at a temperature of 150 F. (66 C).

D–3 *Performance Criteria.* Test each specimen for waterproofness as specified in Section C.

E Micro-Organism Resistance Test

This test is intended to determine the resistance of shower plan materials to mold growth.

E–1 *Specimens.* Each unit of specimens shall consist of twelve samples of material each 1½ in. x 1½ in. sq selected as in B–1.

E–2 *Apparatus, Medium and Test Fungi*

a. Apparatus shall consist of:

An autoclave, capable of maintaining an interior temperature of 122 ± 2 C (251 ± 3.6 F) at a pressure of 15.5 ± 0.5 lb per square in. gauge for the purpose of sterilizing glassware and the medium.

Erhlenmeyer flash, 100 CC capacity.

Glass beads, ¼ in. diameter, 5 pieces.

Glass pipettes, two required.

Wire loop, nichrome wire.

Petri dishes, 10 centimeters in diameter with covers capable of being sealed with cellophane tape. One petri dish is required for each of the twelve samples comprising a test unit.

An incubation chamber, capable of maintaining a temperature 29 ± 1 C (84.5 ± 1.8 F) and a relative humidity of at least 50 percent.

A sterile room, dust free, using sterilamps, antiseptic spray, or air filtration under pressure to maintain sterile conditions.

b. *Test fungi:*

Chaetomium globosum shall be Chaetomium globosum, ATCC 6205.

Aspergillus niger shall be Aspergillus niger ATCC 6275.

c. *Medium:*

A culture medium of the following composition:

NH_3NO_3	3.0 grams
KH_2PO_4	2.5 grams
$MgSO_4.7H_2O$	2.0 grams
K_2HPO_4	2.0 grams
Agar	20.0 grams

Distilled Water to Make 1,000 milliliters

The pH shall be adjusted to a range of 6.4 to 6.8 with HC1 or HaOH as required. This is the base medium for both fungi cultures. However, the medium to be used for the Aspergillus niger shall be especially enriched by the addition of 30 grams of brown sugar.

E–3 *Procedure:*

a. *Medium* as specified in E–2c shall be prepared and poured in the required number of Petri dishes to a depth of ⅜ in.

b. *Sterilize* in the autoclave all of the apparatus in E–2a, including the medium contained in the Petri dishes by retention in the autoclave at the temperature and pressure prescribed in E–2a for 60 minutes. After sterilization, remove to sterile room of E–2a taking care not to contaminate the sterilized equipment and medium. The sterile room shall be used for all preparation procedures.

c. *Cultures, stock and substocks, and inoculum:*

(1) *Chaetomium globosum* fungus stock cultures shall be carefully maintained on strips or squares of sterile porous filter paper, or blotting paper, on a sterilized culture medium as specified in E–2c and E–3b. If there is evidence of contamination, the culture shall be promptly renewed. The culture may be kept for not more than four months in a refrigerator at approximately 3 to 10 C.

Subcultures shall be prepared from a stock culture by transferring spores from the stock culture to a sterilized covered Petri dish containing sterilized medium. The subculture shall then be incubated for a period of 7 to 21 days at 29 ± 1 C (84.5 ± 1.8 F) in the incubation chamber until in a ripe fruiting condition.

Inoculum shall be prepared by transferring the spores with the sterilized wire loop to a sterilized Ehrlenmeyer flask containing 5 sterilized glass beads and 10 ml of distilled water. This mixture shall be shaken sufficiently to break up the spores after which the solution shall be diluted to 200 ml.

(2) *Aspergillus niger* fungus stock cultures shall be carefully maintained as specified in E–3c(1) on a medium as specified in E–2c for this growth.

Subcultures shall be prepared and incubated as in E–3c(1) using a medium as specified in E–2c.

Inoculum shall be prepared as specified in E–3c(1).

d. *Six specimens of each test* unit as defined in E–1, shall be inoculated with each of the two varieties of fungi. Three will be inoculated with the face side up; three with the back side up.

(1) *Preparation:* Each specimen shall be handled under aseptic conditions and shall

be sterilized by dipping in 70 percent ethanol for a few seconds followed by a thorough rinse in distilled water after which each is put in place firmly in the center of the solidified agar medium in its respective Petri dish. Six of the specimens shall be tested with one fungi and six with the other. Also of each subunit of six three shall have one surface in contact with the medium and three with the opposite surface as stated under E–3d.

(2) *Controls* shall be placed in each Petri dish along with the specimen. Each control shall be a strip of sterile blotting paper or filter paper placed on the agar separated from the specimen. The purpose of the control is to provide a medium for the fungi, thus proving that the fungi is active.

(3) *Innoculation* with a particular fungus shall be made by using a sterile pipette individual to the fungus. With the pipette approximately 1.5 ml of inoculum shall be distributed over the specimen, the control and the surrounding medium.

e. *Incubation* of the inoculated specimens shall be for a period of 28 days at a temperature of 29 ± 1 C (84.5 ± 1.8 F) and a relative humidity of 90 percent. An appropriate incubation condition is obtained by placing the covered and sealed Petri dishes in a room or chambers maintained at 85 F and 50 percent relative humidity.

E–4 *Performance Criteria.* Test dishes with controls that do not exhibit a substantial growth of fungi after 7 days of incubation shall be rejected and shall be started anew. A unit test, the controls of which indicate a substantial fungus growth, shall be examined after the required period of 28 days incubation. If after this period any one of the specimens show evidence of evenly distributed or intense localized fugus growth under 16 X magnification on either side of the sample (excluding growth overlapping the edges), the test sample shall be considered to have failed under the test of Section E. See B–2 for details on rejection procedure in event of failure to meet requirements.

Photographs of the specimen taken at the end of the 28 day incubation period are required as part of the test on fungus resistance. Each photograph shall be taken with a scale laid beside the specimen to indicate its size, and the light conditions shall be such that the photographs reveal the nature and height of the fungus growth on the surface of the material. The photographs should be enlarged so the specimen will be a 6 in. x 6 in. size in the enlargement.

F Strength and Toughness Tests.

F–1 *Puncture Resistance Test.* The intent of this test is to determine the resistance of the shower pan material to mechanical damage which might occur during the installation of the shower pan.

a. *Specimens.* Six 10 in. x 10 in. pieces of flat material shall make up each test unit.

b. *Apparatus.*

(1) The specimen holder shall consist of two 10 in. x 10 in. sq pieces of ¾ in. smooth surfaced plywood. One of these pices shall contain a symmetrically located 6 in. x 6 in. opening in the center. The specimen shall be sandwiched between these two specimen holders placing the holder with the opening on top. Four thumb screws located in the center of each side are used to securely clamp the specimen within the holder.

(2) *Impact dart:* A 200 gram steel dart complying with ANSI Z26.1, Safety Code for Safety Glazing Materials for Glazing Motor Vehicles Operating on Land Highways, ANSI Z26.1, shall be used.

C. *Procedure.*

(1) Three specimens shall be tested with one side up and three with the other side up.

(2) Place a single specimen between the holding frame halves and clamp securely by tightening the thumb screws. Suspend the impact dart vertically above the center of the specimen with a vertical distance of three ft between the nose of the dart and the surface of the specimen.

(3) Release the dart for one free fall on each specimen.

d. *Performance Criteria.*

(1) Visible rupture of two specimens of the unit shall require rejection of the material in accordance with B–2.

(2) A specimen which passes this test F–1.d(1) for rupture shall be further hydrostatically tested according to Section C with the point of impact in the center of the test apparatus.

F–2 *Indentation Resistance Test.* To determine the ability of the shower pan material to withstand nail-head indentation without impairing waterproofing.

a. *Specimens.* These shall be as specified in Section C–1.

b. *Apparatus.* The apparatus shall consist of an indenter acting under a total weight of 120 lb, a smooth steel plate as a specimen support, and a rigid form for supporting the indenter and the imposed weight. The indenting head shall be a 0.178 in. diameter steel bar with the pressing face buffed smooth, but not rounded. The rigid support shall hold the indenter vertically so that the indenting face shall contact the specimen in the plane of the contact surface of the specimen when the specimen is placed on the horizontal steel plate. The shaft of the indenter shall be capable of vertical motion along its axis without friction when the weight causing indentation is imposed thereon.

c. *Procedure.* The specimen shall be placed on the supporting plate of the apparatus with the bottom surface up, and then the indenter shall be lowered gently until the indenter face contacts the surface of the specimen. Within one or two seconds the total load of 120 lb shall be applied to the specimen and maintained for a period of sixty minutes.

d. *Performance Criteria.* Each specimen of the test unit shall be hydrostaticaly tested as in Section C with the water contacting each of the specimens on the side opposite the indentation and with the indentation centered in the hydrostatic test specimen holder.

F–3 *Folding Resistance Test.* To determine the ability of the shower pan material to withstand corner folding without impairing waterproofness.

a. *Specimens.* These shall be as specified in Section C–1.

b. *Apparatus.* These shall consist of a 10 lb weight having a smooth flat surface, a ¼ in. diameter mandrel, and a constant temperature chamber to be maintained at 24 ± 2 F.

c. *Procedure.* The specimen, weight, and mandrel shall be placed in the constant temperature chamber and all operations for the bend test shall be accomplished therein. After temperature conditioning the apparatus and the test unit of specimens for four hr at with in ± 2 F. of the temperature indicated in F–3.b, each specimen shall be bent over the mandrel through an angle of 180 F. The bend shall be made in the middle of each specimen and it shall be completed within one second. After this the specimen shall be removed from the mandrel without unfolding and placed on a smooth hard surface for support while the weight is placed on the fold for thirty seconds; the weight being placed so that its force is evenly distributed over the full length of the fold. Unfold each specimen and repeat the bending and weighting operation on each specimen with the second bend being at 90 F to the first and on the same side. Note that all bends shall be made with the surface of the material intended to be toward the shower on the inside of the bend.

d. *Performance Criteria.* After unfolding, each specimen of the test unit shall be hydrostatically tested as in Section C with each specimen placed so that the inside of the fold shall be in contact with the water and the intersection of the two folds are centered in the hydrostatic test specimen holder.

615–9 *Sewage Disposal Systems.*

A Percolation Tests.

A–1 *General.*

a. Subdivisions.

(1) At least one representative test should be made for each significant soil variation encountered or expected.

(2) Each test hole should be located by a key number on a topographic map of the tract.

(3) Soil borings should be made (one every 5 acres, or if subsoil conditions indicate, a greater number will be required) to show clearly the type of soil or soil material existing beneath the absorption area. Borings shall extend to a point at least 6 ft below the finish grade of proposed absorption trenches.

b. Individual Lots. In uniform soils one percolation test should be made for each absorption field site. If significant soil variations are encountered or expected, additional tests should be made for each variation.

A–2 *Test Procedure.* All percolation tests required should be performed in accordance with the following:

a. Dig or bore the holes with horizontal dimensions of from 4 to 12 in. and vertical sides to the depth of the bottom of the proposed absorption device. Holes can be bored with 4 in. diameter post-hole type auger.

b. Roughen or scratch the bottom and sides of the holes to provide a natural surface. Remove all loose materials from the hole. Place about 2 in. of coarse sand or fine gravel in the hole to prevent bottom scouring.

c. Fill the hold with clear water to a minimum depth of 12 in. over the gravel. By

refilling, or by supplying a surplus reservoir of water (automatic siphon), keep water in hole for at least four hr, and preferably overnight. In granular soils, i.e., GW, GP, SW, or SP classified according to the "Unified Soils Classification System," the test can be made after the water from one filling has seeped away.

d. Percolation rate measurements should be made on the day following the saturation process, except in sandy soils.

e. If water remains in the test hole after overnight saturation, adjust the depth to 6 in. over the gravel. From a fixed reference point, measure the drop in water level at approximately 30 minute intervals over a 4 hr period. The drop which occurs during the final 30 minute period is used to calculate the percolation rate. The above 4 hr period may be omitted if the soil has been saturated at least 12 hrs. In which case, the drop which occurs during the 30 minute period following soil saturation is used to calculate the percolation rate.

Note—If a soil or site is determined to be poorly drained with an accompanying high water table, it is unsuitable regardless of percolation test data.

f. If no water remains in the hole after overnight saturation, add clear water to a depth of about 6 in. over the gravel. From a fixed reference point, measure the height of the water surface at approximately 30 minute intervals over a 4 hr period, refilling the hole to a depth of 6 in. when the percolation rate indicates the hole will run dry before the next reading is made. The drop which occurs during the final 30 minute period is used to calculate the percolation rate.

Note—If a hole must be refilled to obtain a final 30 minute reading, determine from the previous reading the water level drop during that interval. Add water until the level above the bottom equals this figure plus one-half in. Continue the test, measuring the drop during the final 30 minute period.

g. In sandy soils, or other soils in which the first six in. of water seeps away in less than 30 minutes, after the overnight saturation period, the time interval between measurements can be taken as 10 minutes and the test run over a period of one hr. The drop which occurs in the final 10 minute period is used to calculate the percolation rate.

Appendix E—Accepted Engineering Practice Standards

Design and construction completed in accordance with the applicable standards in this Appendix shall be considered to satisfy the requirements of the MPS, unless stated otherwise.

601 *General Structural Requirements.*

601–1 Subsurface Soil Exploration.
- Engineering Soil Classification for Residential Developments—HUD Handbook 4075.8.
- Special Procedures for Testing Soil and Rock for Engineering Purposes—ASTM–STP 479.
- Soil Sampling and Testing for Residential Development—HUD Handbook 4075.5.
- Foundations for Residential Structures in Seismic Areas—BRAB Report—National Academy of Sciences, National Research Council—1969.

601–2 Structural Design (Seismic).
- Seismic Design for Building—Department of the Army Technical Manual TM 5–809–10.
- Building Code Requirement for Minimum Design Loads in Buildings and other Structures—ANSI A58.1—For Seismic Zone 3 the provisions of Recommended Lateral Force Requirements and Commentary (1973) of the Structural Engineers Association of California shall apply.

601–16 Foundations.
- Pressure Treated Timber Piles for Permanent Structures—AWPI.
- Pile Foundations Know-How—AWPI.
- Soil Bearing Capacity—Load Testing ASTM D 1194.
- Load Settlement Relationship for Individual Vertical Piles Under Static Axial Load—ASTM D 1143.
- Criteria for Selection and Design of Residential Slabe-on-Ground—BRAB—National Academy of Sciences No. 1571, 1968.
- Method of Laboratory Determination of Moisture Content of Soil—ASTM D 2216.
- ASTM—Special Procedures for Testing Soil and Rock for Engineering Purposes—ASTM STP 479.
- All Weather Wood Foundations System—NFPA Technical Report No. 7.
- Soil Sampling and Testing for Residential Development—HUD Handbook 4075.5.

601–17 Foundations in Seismic Regions.
- Foundations for Residential Structures in Seismic Areas—BRAB Report—National Academy of Sciences—National Resarch Council—1969.
- Seismic Design for Buildings—Department of the Army Technical Manual TM 5–809–10.

602 *Site.*
- Asphalt Pavement Structures for Streets and Highways—Asphalt Institute.
- Installing Vitrified Clay Sewer Pipe—ASTM C12.
- Slope Protection for Residential Developments—HUD Handbook 4075.7.
- Criteria for Compacted Fills—HUD Handbook 4075.6.
- Test for Moisture—Density Relation of Soil–ASTM D 1557.
- Installing Bituminized Fiber Drain & Sewer Pipe—ASTM D 2316.

603 *Concrete.*
- Recommended Practice for Selecting Proportions for Concrete.....ACI 211.1
- Recommended Practice for Selecting Proportions for Structural Lightweight Concrete.....ACI 211.2
- Guide for Structural Lighweight Concrete.....ACI 213
- Recommended Practice for Evaluation of Compression Test Results of Field Concrete.....ACI 214
- Specifications for Structural Concrete for Buildings.....ACI 301
- Recommended Practice for Concrete Floor and Slab Construction.....ACI–302
- Guide to Joint Sealants for Concrete Structures.....ACI 304
- Recommended Practice for Concrete Inspection.....ACI 311
- Manual of Standard Practice for Detailing Reinforced Concrete Structures.....ACI 315
- Building Code Requirements for Reinforced Concrete.....ACI 318
- Structural Plain Concrete.....ACI 322
- Recommended Practice for Concrete Formwork.....ACI 347
- Recommended Practice for Shotcreting.....ACI 506
- Recommended Practice for the Application of Paint to Concrete Surfaces.....ACI 515
- Fabrication, Handling and Erection of Precast Concrete Wall Panels.....ACI 533–19
- Quality Standards and Tests for Precast Concrete Wall Panels...ACI 533–51
- Selection and Use of Materials for Precast Concrete Wall Panels...ACI 533–11
- Recommended Practice for Hot Weather Concreting.....ACI 605
- Recommended Practice for Cold Weather Concreting.....ACI 606
- Recommended Practice for Measuring, Mixing and Placing Concrete.....ACI 614
- Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products...PCI MNL–116
- Manual of Quality Control for Plants and Production of Architectural Precast Concrete Products.....PCI MNL–117
- Control of Quality of Ready-Mixed Concrete.....NRMCA Bulletin No. 44
- Code for Welding in Building Construction.....AWS D1.0
- Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connection in Reinforced Concrete Construction.....AWS D12.1
- Testing Gypsum and Gypsum Products.....UBC 24–26
- Veneer Application, Recommended Standards of ICBO.....UBC 30–1

604 *Masonry.*
- Brick Masonry—Building Code Requirements for Engineered Brick Masonry—SCPI—1969.
- Load Bearing Concrete Masonry—Specifications for the Design and Construction of Load Bearing Concrete Masonry—NCMA—1970.
- Building Code Requirements for Masonry—ANSI A41.1—1953.
- Building Code Requirements for Reinforced Masonry—ANSI A42.2—1960.
- Concrete Masonry Structures—Design and Construction—ACI Committee 531—Report Title No. 67—23a, ACT Journal—May, June 1970.
- Recommended Practices for Cold Weather Masonry Construction—Available from BIA.

605 *Metals.*
- Specification for the Design, Fabrication and Erection of structural Steel For Building—AISC.
- Specification for the Design of Cold-Formed Steel Structural Members—AISI.

Specification for the Design of Light Gage Cold-Formed Stainless Steel Structural Members—AISI.
Standard Specifications for Open Web Steel Joists, J and H Series, Steel Joist Institute—AISC.
Standard Specifications for Long Span Steel Joists, LJ and LH Series, Steel Joist Institute—AISC.
Standard Specifications for Deep, Long Span Steel Joists, DLJ and DLH Series, Steel Joist Institute—AISC.
Manual of Cold-Formed Welded Structural Steel Tubing—Welded Steel Tube Institute.
Design Manual for Structural Steel Tubing—AISI.
Aluminum Formed Sheet Building Sheathing Design Guide—AA.
Specifications for Aluminum Structures—AA Aluminum Standards and Data—AA.
Welding Aluminum—AA.
Metal Curtain Walls, NAAMM Specifications Manual.
D1.1, Structural Welding Code—AWS.
D12.1, Reinforcing Steel Welding Code—AWS.

606 *Carpentry.*
Span Tables for Joists and Rafters and National Design Specifications for Wood Construction—NFPA.
Maximum Span for Joists and Rafters—Southern Forest Products Association Technical Bulletin #2 and Canadian Dimension Lumber—Canadian Wood Council.
Design Criteria for Trussed Rafters—HUD Handbook 4950.2.
Timber Construction Manual—AITC.
Plywood Design Specification—APA Y510.
Design Specifications for Plywood-Lumber Components—APA V815.
Fabrication Specifications, Plywood-Lumber Components—APA V820.
Plywood Diaphragm Construction—APA U310.
Plywood Residential Construction Guide—APA Y405.
Plywood Commercial/Industrial Construction Guide—APA Y300.
Glued Floor System—APA U405.
Adhesives for Field-Gluing Plywood to Wood Framing—APA Specification AFG–01.
Home and Garden Bulletin No. 73; Wood Decay in Houses—How to Prevent and Control It—USDA.
Wood Handbook—USDA.

607 *Thermal and Moisture Protection.*
Recommended Reference Guide—NAHB Insulation Manual for Homes and Apartments.

609 *Finish Materials.*
Specification Manual—National Oak Flooring Manufacturers' Association.
Wood Floors for Dwellings—USDA Handbook No. 204.
Recommended Installation Specification for Vinyl Asbestos Tile Flooring—Resilient Floor Covering Institute.
NRCA Manual of Roofing Practice.

610 *Specialties.*
Standard for Chimneys, Fireplaces and Venting Systems.....NFPA 211

611 *Equipment.*
611–1 Kitchen Cabinets.
Recommended Minimum Construction and Performance Standards for Kitchen and Vanity Cabinets...ANSI A161.1
Certified Construction Standards and Specifications.....SCACM
611–2 Kitchen Equipment.
ANSI Z223.1—National Fuel Gas Code—NFPA UL—Electrical Appliance and Utilization Equipment List.

615 *Mechanical.*
615–2 Mechanical Ventilating.
Ventilation.....HVI AMCA 261
Fan Noise Rating.....HVI Noise Test
Combustion Air Intake...NFPA No. 31, 54 NFPA No. 50
Electical Work.....NFPA No. 70, NEC
Test Procedures—Air Flow and Sound Test Procedures of HVI
Standards for Natural and Mechanical Ventilation.....ASHRAE 62–73
615–3 Heating.
Design Practices:
ASHRAE Guide and Data Books
ASHRAE Handbook of Fundamentals
ASHRAE Cooling and Heating Load Calculation Manual
NESCA Manual J
IBR–H21
SM
NEMA
Installation:
Standard for the Installation of Oil Burning Equipment—NFPA No. 31
Standard for the Installation of Gas Appliances and Gas Piping—NFPA No. 54
Standard for the Installation of Warm Air Heating and Air Conditioning Systems—NFPA No. 90B
Standard for Chimneys, Fireplaces, and Venting Systems—NFPA No. 211
National Electrical Code—NFPA No. 70
Also applicable standards by:
American Insurance Association ASME ANSI/UL, AGA, NECA
Furnaces:
Oil.....ANSI/UL727 & 730
Gas.....AGA listed
Electric.....ANSI/UL573, NFPA 70
Boilers (Steam & Hot Water):
Oil.....MCA, SBI, IBR, UL726 & 296
Gas.....MCA, SBI, AGA, IBR
Electric.....SBI, ANSI/UL174
Radiation:
Baseboard.....IBR rated
Ranned Tube.....IBR rated
Electric.....ANSI/UL, NEMA
Fuel Tanks.....ANSI/UL58
Boiler Ratings:
Net ratings of boilers shall conform to their listing in:
IBR Ratings for (Cast Iron) Boilers—Hydronics Institute.
Net Load Recommendations for Heating Boiler—Mechanical Contractors Association of America.
Directory of Approved Appliances and Listed Accessories—American Gas Association.
Boiler Ratings—Steel Boiler Institute.
Boiler Construction:
Code for Low Pressure Heating Boilers—ASME
Warm Air Furnaces:
One and Two Family Dwelling Code (Under Nationally Recognized Model Codes) Chapters 11, 12, 13, 15 and 16
Hot Water & Steam Systems:
ASHRAE Handbook
IBR Installation Guides
Ducts:
One and Two Family Dwelling Code (Under Nationally Recognized Model Codes) Chapter 16
Self Contained Heating Units:
One and Two Family Dwelling Code (Under Nationally Recognized Model Codes) Chapter 14, Vented Decorative Appliances, Floor Furnaces, Vented Wall Furnaces and Vented Room Heaters
Gas Vents:
One and Two Family Dwelling Code (Under Nationally Recognized Model Codes) Chapter 15, Venting of Appliances
Heat Output of Radiator, Baseboard and Convector Systems:
IBR Test
Product Standard (PS)
Commercial Standard (CS)
615–4 Mechanical Cooling.
Summer Air Conditioning—Central Design:
ASHRAE Handbook
ASHRAE Cooling and Heating Load Calculation Manual
ARI Standard 230, ANSI/UL465
ACCA Manual J
NFPA Standard 90B
IBR C 30
SMACNA Installation Standard and Guides
NEMA
Summer Air Condtioning—Room Units:
ANSI/UL 484
ANSI Z234.1
Refrigeration System:
ANSI B9.1
ANSI Z21.40.1 Gas Fired Units
ANSI Z21.40.1a Gas Fired Units—Addenda
Gas Piping and Systems:
NFPA No. 54
NFPA No. 58
Oil Systems:
NFPA No. 31
Safety:
ANSI B15.1
Electrical:
NEC
ANSI/UL—No. 465
Heat Pump:
ARI 240
ANSI/UL 559
615–5 Plumbing.
Joints and Connections:
ASTM C 564; CISPI–HSN; CISPI 301; CISPI 310; CISPI Cast Iron
Soil Pipe and Fittings Engineering Manual; CISPI Cast Iron
Soil Pipe and Fittings Handbook
Pipe Protection:
AWWA—C—204
Water Conditioner:
WQA S–100
Plumbing, Drainage and Venting Systems
Chapter 22—One and Two Family Dwelling Code (BOCA, NBC, SSBC and UBC)
615–6 Domestic Water Heating Systems and Storage.
Electric Hot Water Heater Standards:
EEI, FS, ANSI/UL174

Gas Hot Water Heaters:
AGA—listed
Oil Hot Water Heaters:
ANSI/UL732
Water Heater Controls:
ANSI Z21.22
Pressure Relief Valves—Water Heaters:
NBBPVI, AGA
Hot Water Tank Construction:
ANSI Z21.10
Service Water Heating:
ASHRAE Handbook
615–7 Special Piping Systems.
NFPA Standards 54 and 58
615–8 Water Supply.
Drinking Water Standards:
U.S. Public Health Service Drinking Water Standards
U.S. Environmental Protection Agency, National Interim Primary Drinking Water Regulations, effective June 24, 1977, **Federal Register**, December 24, 1975 and July 9, 1976
Individual Water Systems:
Manual of Individual Water Supply Systems—U.S. Environmental Protection Agency
615–9 Sewage Disposal System.
HUD Handbook 4075.8
HUD Handbook 4940.3
Installing Vitrified Clay Pipe Sewers.....ASTM C 12
Underground Installation of Flexible Thermoplastic Sewer Pipe....ASTM D 2321
Percolation Test Procedure:
See Appendix D
616 *Electrical.*
616 Materials and Installation.
NEC, UL

APPENDIX F—Use of Materials Bulletins

Appendix F is a partial list of Use of Materials Bulletins describing products and methods which are not included in the standard but which have been found to be technically suitable for use in HUD programs.

505 *Metals.*
Application and Fastening Schedule Power, Mechanically and Manually Driven Fasteners.....No. UM–25

506 *Carpentry.*
Mat-Formed Wood Particleboard for Floor Underlayment.....No. UM–28
Grade Marking of Lumber.....No. UM–38
Grade Marking of Plywood.....No. UM–40
Labels of Independent Programs for Certifying Pressure Treated Lumber and Plywood.....No. UM–48
Supplement 1.....No. UM–48
Supplement 2.....No. UM–48
Supplement 3.....No. UM–48
Supplement 4.....No. UM–48
Supplement 5.....No. UM–48
Combination Subfloor/Underlayment Particleboard for Factory Built Modular Housing Units.....No. UM–57
Plywood Combination Subfloor/Underlayment Floor Panel.....No. UM–66
Particleboard Interior Stair Treads.....No. UM–70
Field Glued Plywood & Wood Frame Structural Floor Systems...No. UM–60
Supplement 1.....No. UM–60
Supplement 2.....No. UM–60

507 *Thermal and Moisture Protection.*
Polystyrene Foam Insulation Sheathing Board.....No. UM–71
Thermal Insulation, Urea-Based, Foamed in Place.....No. UM–74
Spray Applied Cellulosic Thermal Insulation.....No. UM–80

508 *Doors, Windows, Glazing Panels.*
Labels of Independent Programs for Certifying Aluminum Windows and Sliding Glass Doors.....No. UM–39
Quality Certification and Labeling for Wood Flush Doors.....No. UM–52
Acrylic Plastic Sheets for Glazing.....No. UM–58
Labels Identifying Independent Certification of Wood Windows...No. UM–59
Polycarbonate Plastic Sheets for Glazing.....No. UM–67

509 Finish Materials.
Concrete Roofing Tile.....No. UM–17
Minimum Standands for Carpeting and Cushioning.....No. UM–44
Bonded Urethane Carpet Cushion.....No. UM–47
Textured Plywood Panel Siding...No. UM–64
Factory-Applied Laminated Roofing Systems Based on Chlorosulfonated Plyethylene (CSPE).....No. UM–62
Controlled Density Cellular Concrete Floor Fill.....No. UM–65
Self-Adhering Vinyl Asbestos Floor Tile.....No. UM–69

515 Mechanical.
Plastic Bathtubs, Plastic Shower Stalls and Receptors and Plastic Lavatories.....No. UM–73
Chlorinated Poly (Vinyl Chloride) CPVC and Polybutylene (PB) Hot and Cold Water Distribution Piping.....No. UM–76
Cast Iron Sanitary Drainage System with Hubless Pipe and Fittings.....No. UM–77
Polyethylene (PE), Acrylonitrile-Butadiene-Styrene (ABS), Poly (Vinyl Chloride) (PVC) and Polybutylene (PB) Plastic Piping for Domestic Cold Water Service...No. UM–78
Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings.....No. UM–79

APPENDIX G

SI Conversion Units

In view of the present accepted practice in this country for building technology, common U.S. units of measurement have been used throughout this publication. In recognition of the Metric Conversion Act of 1975, P.L. 94–168, appropriate conversion factors have been provided in the table below. The reader interested in making further use of the coherent system of SI units is referred to:

NBS SP330, "The International System of Units"
ASTM E380, Metric Practice Guide (ANSI Z210.1)

Table of Conversion Factors to Metric (SI) Units

Physical Quality	To convert from	to	multiply by
Length	inch foot	meter m	$2.54^{*} \times 10^{-2}$ $3.048^{*} \times 10^{-1}$
Area	$inch^2$ $foot^2$	m^2 m^2	$6.4516^{*} \times 10^{-4}$ $.290 \times 10^{-2}$
Volume	$inch^3$ $foot^3$	m^3 m^3	1.639×10^{-5} 2.832×10^{-2}
Temperature Temperature difference	Fahrenheit Fahrenheit	Celsius Kelvin	$t_c = (^tF-32)/1.8$ $K = (\ ^tF)/1.8$
Pressure	inch Hg (60F)	$newton/m^2$	3.377×10^3
Mass	lbm	kg	4.536×10^{-1}
Mass/unit area	lbm/ft^2	kg/m^2	4.882
Moisture content rate	lbm/ft^2 week	kg/m^2s	8.073×10^{-6}
Density	lbm/ft^3	kg/m^3	1.602×10^1
Thermal conductivity	$(Btu \times in.)/(hr \times ft^2 \times F)$	$\frac{W}{mK}$	1.422×10^{-1}
U-value	$Btu/hr \times ft^2 \times F$	$\frac{W}{m^2K}$	5.678
Thermal resistance	$(hr \times ft^2 \times F)/Btu$	$m^2 \times K/W$	1.761×10^{-1}

*Exact value; others are rounded to fourth place.

Appendix H—Minimum Property Standards Reference Sources

This Appendix gives the addresses from which the standards referenced in the Minimum Property Standards can be obtained.

Abbreviation and Address

AA Aluminum Association, The, 818 Connecticut Ave., N.W., Washington, DC 20006;

AAMA Architectural Aluminum Manufacturers Association, 35 East Wacker Dr., Chicago, Illinois 60601;

ACCA Air Conditioning Contractors of America, 1228 17 St., N.W., Washington, DC 20036;

ACI American Concrete Institute, P.O. Box 19150, Redford Sta., Detroit, Michigan 48219;

AGA American Gas Association, 1515 Wilson Blvd., Arlington, Virginia 22209;

AHA American Hardboard Association, 205 West Touhy Ave., Park Ridge, Illinois 60068;

AHLI American Home Lighting Institute, 230 North Michigan Ave., Chicago, Illinois 60601;

AISC American Institute of Steel Construction, Inc., 1221 Avenue of the Americas, New York, New York 10020;

AISI American Iron and Steel Institute, 1000 16th St., N.W., Washington, DC 20036;

AITC American Institute of Timber Construction, 333 W. Hampden Ave., Englewood, Colorado 80110;

ALSC American Lumber Standards Committee, Suite 204, 20010 Century Blvd., Germantown, Maryland 20767;

ANSI American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018;

APA American Plywood Association, 1119 A St., Tacoma, Washington 98401;

ARI Air-Conditioning and Refrigeration Institute, 1815 North Fort Myer Drive, Arlington, Virginia 22209;

ARMA Asphalt Roofing Manufacturers Association, Suite 555B, 230 Park Ave., New York, New York 10017;

ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., 345 East 47th St., New York, New York 10017;

ASME American Society of Mechanical Engineers, Inc., 345 East 47th St., New York, New York 10017;

ASTM American Society for Testing and Materials, 1916 Race St., Philadelphia, Pennsylvania 19103;

AWPA American Wood-Preservers' Association, Suite 4444, 7735 Old Georgetown Rd., Bethesda, Maryland 20014;

AWPB American Wood Preservers Bureau, Box 6085, 2772 S. Randolph St., Arlington, Virginia 22206;

AWPI American Wood Preservers Institute, 1651 Old Meadow Rd., McLean, Virginia 22101;

AWS American Welding Society, Inc., 2501 N.W. 7th St., Miami, Florida 33125;

AWWA American Water Works Association, 6666 W. Quincy Ave., Denver, Colorado 80235;

BIA Brick Institute of America, 1750 Old Meadow Rd., McLean, Virginia 22101;

BOCA Building Officials and Code Administrators, International, Inc., 1313 East 60th St., Chicago, Illinois 60637;

BRAB Building Research Advisory Board, National Academy of Sciences, 2101 Constitution Ave., N.W., Washington, DC 20006;

CFR Code of Federal Regulations, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402;

CISPI Cast Iron Soil Pipe Institute, 2020 K St., N.W., Washington, DC 20006;

CHA Cellulose Manufacturers Association, 5908 Columbia Pike, Baileys Crossroads, Virginia 22041;

CPSC Consumer Product Safety Commission, 1111 18th St., N.W., Washington, DC 20207;

CRI The Carpet and Rug Institute, 310 Holiday Ave., Box 2048, Dalton, Georgia 30720;

CS National Bureau of Standards, Technology Building B166, VPS Program, Washington, DC 20234;

CTI Ceramic Tile Institute, 700 North Virgil Ave., Los Angeles, California 90029;

CWC Canadian Wood Council, 701 Place Laurier, 170 Laurier Ave., West Ottawa, Ontario KIP 5V5;

EPA Environmental Protection Agency, 401 M St., S.W., Washington, DC 20460;

FHDA Fir and Hemlock Door Association, Yeon Building, Portland, Oregon 97204;

FS GSA Specification Section, Building 197, Washington Navy Yard, Washington, DC 20407;

HPMA Hardwood Plywood Manufacturers Association, 1825 Michael Faraday Drive, Reston, Virginia 22090;

HVI Home Ventilating Institute, 230 N. Michigan Ave., Chicago, Illinois 60601;

HYDI The Hydronics Institute, 35 Russo Place, Berkeley Heights, New Jersey 07922;

IBR See HYDI;

ICBO International Conference of Building Officials, 5360 S. Workman Mill Road, Whittier, California 90601;

IES Illuminating Engineering Society, 345 East 47th St., New York, New York 10017;

MCA Mechanical Contractors Association of America, Inc., 5530 Wisconsin Ave., N.W., Suite 750, Washington, DC 20015;

NAAMM National Association of Architectural Metal Manufacturers, 1031 South Boulevard, Oak Park, Illinois 60302;

NAHB National Association of Home Builders of the U.S., 15th & M Sts., N.W., Washington, DC 20005;

NAHB-RF National Association of Home Builders, Research Foundation, 627 Southlawn Lane, Rockville, Maryland 20850;

NBBPVI National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Ave., Columbus, Ohio 43229;

NCMA National Concrete Masonry Association, 6845 Elm St., McLean, Virginia 22101;

NEC See National Fire Protection Association;

NEMA National Electrical Manufacturers Association, 2101 L St., N.W., Washington, DC 20037;

NESCA See ACCA;

NFPA National Fire Protection Association, 470 Atlantic Ave., Boston, Massachusetts 02210;

NFPA National Forest Products Association, 1619 Massachusetts Ave., N.W., Washington, DC 20036;

NOFMA National Oak Flooring Manufacturers Association, 804 Sterick Building, Memphis, Tennessee 38103;
NPA National Particleboard Association, 2305 Perkins Place, Silver Spring, Maryland 20910;
NRCA National Roofing Contractors Association, 1515 North Harlem Avenue, Oak Park, Illinois 60302;
NRMCA National Ready Mixed Concrete Association, 900 Spring St., Silver Spring, Maryland 20910;
NTMA National Terrazzo and Mosaic Association, Inc., 2–A West Loudoun St., Leesburg, Virginia 22075;
NWMA National Woodwork Manufacturers Association, Inc., 400 West Madison St., Chicago, Illinois 60606;
One- and Two-Family Dwelling Code, Congress of American Building Officials, 560 Georgetown Building, 2233 Wisconsin Ave., N.W., Washington, DC 20007;
PS See CS;
SBI See HYDI;
SCACM Southern California Association of Cabinet Manufacturers, 1933 S. Broadway, L.39, Los Angeles, California 90007;
SCPI See BIA;
SGCC Safety Glazing Certification Council, 1640 West 32nd Ave., Hialeah, Florida 33012;
SJI Steel Joist Institute, Suite 204, 1703 Parham Rd., Richmond, Virginia 23229;
SMACNA Sheet Metal and Air Conditioning Contractors, National Association, Inc., 8224 Old Courthouse Rd., Vienna, Virginia 22180;
SPMA Sump Pump Manufacturers Association, 221 North LaSalle St., Chicago, Illinois 60601;
SBCC Southern Building Code Congress International, Inc., 900 Montclair Rd., Birmingham, Alabama 25213;
TCA Tile Council of America, Inc., Box 326, Princeton, New Jersey 08540;
TECO Timber Engineering Company, 5530 Wisconsin Ave., N.W., Washington, DC 20015;
TM Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402;
UBC Uniform Building Code by ICBO, 5360 South Workman Mill Rd., Whittier, California 90601;
UL Underwriters Laboratories, 333 Pfingsten Road, Northbrook, Illinois 60062;
USDA U.S. Department of Agriculture, 1200 to 1400 Independence Ave., Washington, DC 20024;
WM Wood Moulding and Millwork Producers, Inc., P.O. Box 2578, Portland, Oregon 97225;
WQA Water Quality Association, 477 East Butterfield Rd., Lombard, Illinois 60148;
WSTI Welded Steel Tube Institute, 522 Westgate Tower, Cleveland, Ohio 44116.

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